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SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
Bulletin 64

A CRITICAL SUMMARY OF TROOST'S UNPUBLISHED MANUSCRIPT ON THE CRINOIDS OF TENNESSEE

BY

ELVIRA WOOD

Of Columbia University, New York City

WASHINGTON
GOVERNMENT PRINTING OFFICE
1909

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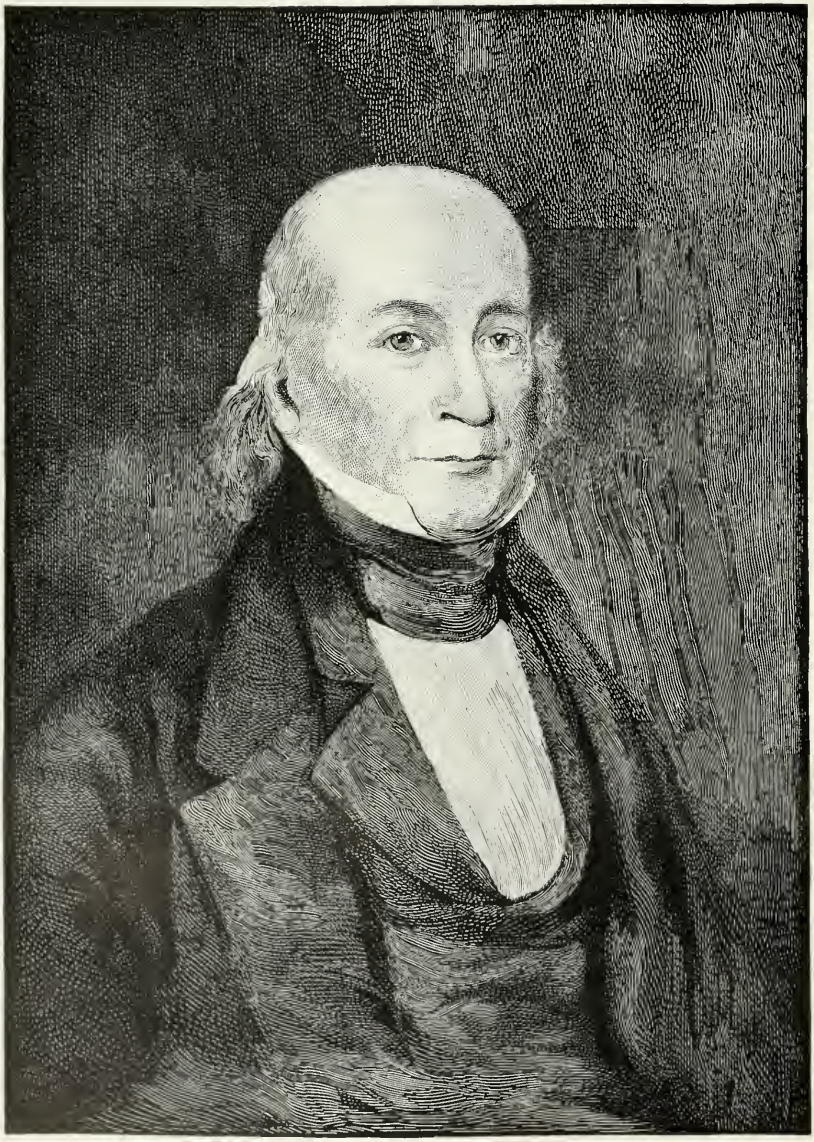

GERARD TROOST,

State Geologist of Tennessee.

SMITHSONIAN INSTITUTION
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BULLETIN OF THE UNITED STATES NATIONAL MUSEUM.

Issued May 8, 1909.

ADVERTISEMENT.

The scientific publications of the National Museum consist of two series—the *Bulletin* and the *Proceedings*.

The *Bulletin*, publication of which was begun in 1875, is a series of more or less extensive works intended to illustrate the collections of the U. S. National Museum and, with the exception noted below, is issued separately. These bulletins are monographic in scope and are devoted principally to the discussion of large zoological and botanical groups, faunas and floras, bibliographies of eminent naturalists, reports of expeditions, etc. They are usually of octavo size, although a quarto form, known as the Special Bulletin, has been adopted in a few instances in which a larger page was deemed indispensable.

This work forms No. 64 of the Bulletin series.

Since 1902 the volumes of the series known as "Contributions from the National Herbarium," and containing papers relating to the botanical collections of the Museum, have been published as bulletins.

The *Proceedings*, the first volume of which was issued in 1878, are intended as a medium of publication of brief original papers based on the collections of the National Museum, and setting forth newly acquired facts in biology, anthropology, and geology derived therefrom, or containing descriptions of new forms and revisions of limited groups. A volume is issued annually, or oftener, for distribution to libraries and scientific establishments, and in view of the importance of the more prompt dissemination of new facts a limited edition of each paper is printed in pamphlet form in advance.

RICHARD RATHBUN,
Assistant Secretary, Smithsonian Institution,
In Charge of the United States National Museum.

WASHINGTON, U. S. A., *April 15, 1909.*

PREFACE.

In the history of American paleontology the name of Gerard Troost must always fill a conspicuous place. Doctor Troost was born at Bois-le-Duc, Holland, on March 15, 1776.[a] His collegiate training was received in the University of Leyden, where he was graduated as doctor of medicine. He also received the degree of master of pharmacy, and practiced that profession in his native country for six years.

In 1807 Doctor Troost went to Paris, where he continued his scientific studies, and during his residence in that city he met and freely associated with the leading scientific men of the time. Haüy was his teacher, and Humboldt and Werner were among his friends.

Under the patronage of Louis Napoleon, King of Holland, Troost traveled extensively in western Europe, and in 1809 was appointed a member of a scientific commission to be sent to the island of Java; but, owing to the disturbed political conditions of the time the expedition was abandoned, and in 1810 he came to this country. He settled in Philadelphia, where his social qualities as well as his scientific attainments won for him early recognition from the scientific men of that city. He became one of the founders and the first president of the Philadelphia Academy of Sciences, retaining that office for five years. While in Philadelphia Doctor Troost delivered courses of lectures on mineralogy and chemistry, and also made a geological survey of the environs of Philadelphia.

In 1827 Doctor Troost moved to Tennessee, where he was shortly after invited to accept the chair of geology and mineralogy in the University of Nashville, a place which he held for the remainder of his life. Later, the office of geologist of the State of Tennessee was created and given to Doctor Troost. His researches within the State gave an important impulse to the development of the natural resources of Tennessee, and it was while traveling in connection with his work that he made the collection of crinoids which form the basis of this bulletin.

[a] For the facts here given the writer is indebted to the excellent biographical sketch of Doctor Troost by Mr. L. C. Glenn (1905).

Doctor Troost's work as a paleontologist reveals the accurate observation and logical interpretation of the trained naturalist, and while erroneous in some minor particulars, is yet remarkably good when one considers the almost unknown path he followed in this field of science. The monograph on the crinoids of Tennessee was the last of his scientific labors, and was performed with some difficulty, as shown by the pathetic reference to his failing health at the end of his introductory description of the geology of Tennessee. His death occurred on August 14, 1850, only four weeks after his monograph was completed and sent to the Smithsonian Institution for publication.

Doctor Troost brought to the new world a wide experience and broad culture obtained in the riper civilization of the old, and to this he added high character and a public spirit which made him a valuable acquisition to the life of his adopted country.

The following revision of Doctor Troost's monograph on the crinoids of Tennessee was prepared at the request of the authorities of the United States National Museum. The reasons for the long delay are given in the introductory paragraphs of the bulletin.

This work was begun while the writer was connected with the United States Geological Survey as assistant in paleontology, and has been completed at Columbia University, where it was presented as a thesis in connection with the degree of master of arts in 1908.

ELVIRA WOOD.

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A CRITICAL SUMMARY OF TROOST'S UNPUBLISHED MANUSCRIPT ON THE CRINOIDS OF TENNESSEE.

By Elvira Wood,[a]
Of Columbia University, New York City.

INTRODUCTION.

At a meeting of the American Association for the Advancement of Science, on August 14, 1849, Prof. Louis Agassiz read a short paper entitled: "A List of the Fossil Crinoids of Tennessee. By Professor G. Troost, of Nashville." He says [Agassiz, 1849, p. 62] of this list:

> No doubt it is as correct as such lists can be expected to be, and * * * in every respect a monograph would be a highly valuable addition to our knowledge; and I am happy to be able to state that Professor Troost is preparing a monograph of all these crinoids, illustrated by 220 figures.

The list contained the names of only 85 of the 108 species described in the final paper.

The monograph was finished during the following year and sent to the Smithsonian Institution for publication July 18, 1850. Troost died in August of the same year, and his manuscript, in accordance with a custom of the institution, was submitted for revision to a committee consisting, in this case, of Prof. James Hall and Prof. Louis Agassiz.

The subsequent history of the manuscript has been given by Prof. Charles Schuchert [1904, pp. 219–221] and Mr. L. C. Glenn [1905, pp. 79–81]. From these accounts it appears that the manuscript and specimens were sent first to Professor Hall, who transmitted them to Professor Agassiz for revision. When at the end of five years the manuscript was still unrevised, Agassiz returned it to Professor Hall, and the cover bears the following note, "Received from Professor Agassiz in Cambridge, August 23d, 1855, James Hall."

[a] The writer takes pleasure in acknowledging her indebtedness to Prof. Charles Schuchert, of Yale University, at whose suggestion the manuscript of Doctor Troost was submitted to her for revision, and to Dr. Charles D. Walcott for 39 photographs used in the illustration of this paper. Also to Dr. Ray S. Bassler for photographic illustrations and for suggestions in connection with the geology of Tennessee, and to Dr. A. W. Grabau, of Columbia University, for valuable advice.

Hall retained the manuscript and fossils for the remainder of his life time, more than forty years, and after his death they were, at the request of Secretary Langley, returned by the acting administrator of his estate to the Smithsonian Institution. While the manuscript was in Hall's possession he published four of Troost's genera, quoting Troost's descriptions of three of them. He also published descriptions of ten of the species the names of which had already been published by Troost [1850, pp. 60–62]. In each of these cases Hall used as a type a specimen from another locality supposed to be identical with the type of Troost. The descriptions, however, were written by Professor Hall, Troost's description, then in his possession, being quoted in one case only, that of *Zeacrinus magnoliæformis*.

Prof. John M. Clarke [1905, pp. 256–257], writing with reference to the matter, says:

> There was not in the entire immense collection which his [Hall's] death left among his assets a single claim which had not been fully extinguished either by payment of money or by transference of copies of his books which had cost him money. By the latter method the Troost title was extinguished, and Hall had long before his death acquired full right to use the materials as he saw fit.

Earlier in the same paper he says:

> I am not acquainted with the proceedings by which this acquisition was finally effected. Doubtless the transfer was gradually worked out and a full equivalent rendered therefor.

Meanwhile the matter of the Troost manuscript had apparently been quite forgotten by the Smithsonian authorities, as shown by the reply to Meek's inquiries regarding it. The letter, which has been published [Schuchert, 1904, p. 220] is as follows:

> WASHINGTON, D. C., *July 21, 1868.*
>
> MY DEAR MR. MEEK: I can tell you nothing about present condition of Troost's paper or what Professor Hall has done or will do with it. Nor does Professor Henry remember anything of any plan or arrangement. We have published nothing and know of no publication.
>
> Sincerely yours, S. F. BAIRD.
>
> F. B. MEEK, *Springfield, Ill.*

Interest in the manuscript was revived by Prof. Charles Schuchert, formerly of the U. S. National Museum, and the present publication is largely due to the earnest desire of Professor Schuchert and of his successor, Doctor Bassler, that justice should at last be done the memory of this pioneer in the study of American Crinoidea. Troost died believing that his monograph would soon be published, and it is much to be regretted that it was not done while so much of the material was new to science, and while the beautiful specimens he loved could be associated with his name.

In the following pages the manuscript of Doctor Troost, printed in small type, is given nearly in full, for while parts of it are no longer

of especial scientific interest, they are of historical interest, and they give us a better acquaintance with the interesting personality of the author.

The monograph as presented at the Smithsonian Institution contained 91 pages closely written by Troost's own hand, with complete index and description of plates. It is fully illustrated, 243 figures being used to illustrate the 108 species described. The drawings, while effective as pictures, omit important details, and they have been replaced in many cases by retouched photographs or original drawings.

The introduction to the monograph contains a general description of the geology of Tennessee, followed by the descriptions of species grouped under the following phylum and classes and in the following order:

Radiata [Echinoderma].
Stellerides [Stelleroidea].
Echinides [Echinoidea].
Crinoidea.

Several species belonging to the Cystoidea and Blastoidea are described among the Crinoidea without separate heading. As here published the species are rearranged in accordance with the classification proposed by Dr. F. A. Bather [1900] for blastoids and crinoids and to correspond with that of Jaekel [1899] for cystoids.

The following title and dedication are quoted exactly from the original manuscript.[a]

A MONOGRAPH ON CRINOIDS (?)[b]

DISCOVERED IN THE STATE OF TENNESSEE.

By Dr. G. Troost.

Prof. Chem. Miner. and Geology in the Nashville University, Geologist of the State of Tennessee. Heretofore *Officier de santé de la première classe au service de S. M. Louis Napoleon Roi de Hollande.* One of the seven founders, and first President or the Academy of Natural Sciences of Philadelphia, Penn. Member of the Philosophical Society in Philadelphia; Member of the American National Institute; member of the Geological Society of France; corresponding member of the Jardin des plantes; member of the Society of Natur- and Letterkunde in The Hague,—of the American Ethnological Society in New York,—of the Western Academy of Natural Science in St. Louis, Missouri,—of the Historical Society in Nashville, Tenn. etc.

DEDICATION.

Nashville, *October, 1849.*

To the Citizens of Nashville,

Fellow Citizens:—I take great pleasure in dedicating this work to you. It is the result of several years' research and travel, and I owe it to you that I have been able

[a] Quotations from Doctor Troost's manuscript are printed in small type, with insertions by the author inclosed in square brackets.

[b] Troost's material contained cystoids, blastoids, crinoids, asteroids, and a pseudomorph of uncertain affinities.—E. W.

to execute it. In no place have I been received with more kindness than in Nashville. Even soon after my arrival in your city the board of trustees of your University established the professorship of mineralogy and geology which they conferred on me. I have ever found amongst you my most cordial friends.

This work treats of animals which innumerable ages ago inhabited this globe. Their remains are found dispersed through the rocks of which you construct your dwellings. No state or country of the same extent is as rich in these productions as the State of Tennessee, and to spread the name of my adopted state amongst the scientific world was my principal aim.

With much consideration and gratitude,

Your humble servant, G. TROOST.

INTRODUCTORY.

When 25 years ago I entered for the first time the State of Tennessee, a country, according to the map of Mr. W. Maclure, composed of recent strata from its most eastern limit to its most western boundary, the Mississippi River, I was very much surprised to find in the vicinity of Nashville, the centre of the State and about 300 miles from the eastern limit, fossils which belonged to a formation which was then called Graywacke or Transition formation, and my subsequent excursions towards the eastern limit showed me at several places, as at the Roan Mountains in Carter County, that even the Crystalline rocks, such as granite [gneiss] existed in this state, while the Cretaceous and Green Sand strata, characterized by *Exogyra costata*, *Gryphaea*, *Hamites*, extended towards the Mississippi, forming near Memphis the very bank of this river.[a] I have therefore thought proper to commence this Monograph by a general outline of the Geology of the state in which the Crinoids described were found.

The fossiliferous strata west of the Appalachian Mountains, a ramification of which separates the State of Tennessee from that of North Carolina, whilst several subordinate branches of it traverse Tennessee from north east to south west,[b] are separated from the Crystalline or primordial rocks by the principal or highest ridge of this Appalachian chain. The highest elevation is the Smoky Mountain, which forms the boundary between Tennessee and North Carolina, and is a continuation of the Appalachian. It is granitic to about where the Tennessee river enters into Tennessee, in the County of Monroe.[c] The western slope of the mountain in this county is composed of psammite or slate, which forms here the highest ridge and assumes the name of Unaka Mountain, continuing into McMinn County, where the primordial rocks again enter the State of Tennessee, running to the Amoce River where they are again replaced by psammitic rocks. The line of junction of these two formations is almost the same as the boundary which separates South Carolina from the State of Tennessee.

---

[a] The bluffs at Memphis are now known to be of Quaternary age, mainly Loess. From the list of fossils given it is evidently the Selma clay to which Doctor Troost refers, and outcrops of this formation are not reported west of McNairy and Henderson counties in southern Tennessee.—E. W.

[b] The Cumberland Mountains are a group which enters the State of Tennessee at the Cumberland Gap, traverses Tennessee from northeast to southwest, and forms in this state several ramifications which are called Walden's Ridge, Clinch Mountains, Stone Mountain, Cumberland Mountains, Crab-orchard Mountains, and several other minor ramifications which terminate partly in the State of Tennessee and partly in Alabama where they form the Raccoon, Look-out, and several other mountains.—Troost.

[c] The greater part of the Smoky Mountain range is of slates and conglomerates referred to the "Ocoee" series. The nearest exposures of the highly crystalline rocks, constituting the Metamorphic Group of Safford, appear to the north in a small area near the state line in Cocke County, and to the southwest in Monroe County where the Tellico River crosses the range.—E. W.

Towards the west of this line in Carter County, including Roan Mountain, the granite prevails to about 12 miles west; then the granite retreats towards the east, and soon, about the head of Indian Creek, it repasses the Tennessee line. We have then a Silurian [Chilhowee] passing through Cocke County to Wolf Creek where the crystalline rocks again enter Tennessee.

The highest ridge of the crystalline rocks is at the same time pretty nearly the boundary line which separates North Carolina from the State of Tennessee, and it is towards the west of this boundary that the fossiliferous strata make a beginning and extend westwards, without interruption, as far as the head waters of St. Francia River in the State of Missouri, where syenitic and hornblende rocks make their appearance. Proceeding from the primordial or granite rocks in East Tennessee, we have first a formation of slaty and conglomerate rocks, extending for several miles and composed of slaty talc, roofing slate and several varieties of conglomerates generally called Grauwacke [Ocoee series]. The ridge called Bay's Mountain traverses the State of Tennessee 100 miles in a direction from north east to south west, dividing the counties of Blount and Sevier from that of Knox, entering then Jefferson County, and separating Green from Hawkins County where it forms Chimney Top Mountain; continuing thence more northwards towards Kingsport in Sullivan County where it constitutes the elevated bank of the Holston River and terminates. This is the dividing line between the Silurian and non-fossiliferous rocks.[a] The lowest Silurian strata begin then, as I have observed, somewhere near the boundary line which separates North Carolina from Tennessee, protruding sometimes for a few miles into North Carolina, sometimes into Tennessee, forming the Unaka, or Smoky Mountains, [Ocoee series] the Bald Mountains, and the Iron Mountains, [Chilhowee series] the culminating points of these mountains being generally composed of rocks in which I never found any fossils, while towards the east and south east the crystalline rocks prevail.

Leaving this ridge and continuing in a direction from north or rather north west, we traverse a series of slaty rocks, which are sometimes chloritic and talcose containing much quartz. It is there that the first limestone makes its appearance. It is generally of a brown or reddish brown color, and of a fine granular structure and appears to contain magnesia [Knox dolomite]; but I never found any trace of organic remains in it. Such also is the limestone [Shady limestone] on the French Broad River about five miles west from the granitic rocks which traverse the roads near the warm springs in Buncombe County, N. Carolina. Upon the above named limestone follows a series of alternating strata of sandstone and slaty rocks, as above mentioned, till about four or five miles south from Newport on the French Broad River, where the granular limestone makes its appearance again and traverses Cocke and Sevier counties in a direction parallel to the principal ridge. They contain (I suppose) no fossils.

Upon the rocks mentioned above, follow another series [Ocoee] composed of roofing slate, glossy aluminous slate and sandstone. A stratum of roofing slate traverses Sevier County [Ocoee series]. This series [the Chilhowee] commences with the Stars, Tellico and Chilhowie Mountains in McMinn, Monroe and Blount Counties and continuing parallel to the Smoky Mountain in a south east direction, traverses Sevier County. This series terminates towards the north by Bay's Mountain which is composed of sandstone in which I did not discover any fossils. All these strata are highly inclined, almost vertical.

Towards the north of the above detailed series we arrive upon a series of limestone strata in which fossils make their appearance, and increase as we proceed towards the north west. The first fossils observed towards the north of Bay's Mountain are some species of *Orthoceratites* and a species of *Euomphalus* described by Mr. Lesueur under the name of *Maclurites* [*Maclurea*] and discovered by him near Lake Superior.[b] The

[a] The Sevier shale east and west of Bay's Mountain is now known to be fossiliferous.—E. W.

[b] Probably Lake Champlain.—E. W.

strata in which they occur are more or less inclined, but they assume soon a horizontal direction. I consider these strata as belonging to the lower division of the Silurian system, being characterized by *Calimena Fisheri*, which are found in the vicinity of Knoxville. This series extends northwards to the State of Virginia. The ridge which runs parallel to Bay's Mountain and which commences in Knox County traversing Granger and Hawkins Counties, where it forms the Clinch Mountain and which is principally composed of sandstone and aluminous slate, containing extensive deposits of calamine and hydroxide of iron, seems to be analogous to Bay's Mountain.[a]

I have not yet determined to which division of the Silurian system the strata of limestone east of the Cumberland Mountains belong—It is very probable that they belong to the lower division—perhaps they are equivalent to what Murchison calls Llando [probably Llandeilo] flags. I found in some the *Calimena Fisheri*, etc.[b]

The above described formations are separated from the more western (which form Middle Tennessee) by the Cumberland Mountains which traverse the State of Tennessee in a south east [west] and north west [east] direction, and are composed of a series of parallel ridges known under the names of Walden's Ridge, Craborchard Mountain, Cumberland Mountain, Brimstone Mountain etc. They all belong to the Carboniferous formation and are formed of limestone, sandstone and coal strata. Near the Craborchard the limestone stratum [Bangor limestone] pierces through the superincumbent sandstone. It is of oolitic structure and is characterized by *Demonocrinites* [*Talarocrinus symmetricus*] and by those *Pentremites* which characterize the Carboniferous limestone in Kentucky, Tennessee and Alabama, and it forms generally the base of that mountain. It is particularly displayed near Sparta, where the whole stratification is visible. The Sequatchie Valley displays also the stratification of this mountain. The bottom of this valley, through which winds longitudinally the Sequatchie River, is generally of Silurian [Ordovicic] strata of two different ages. The south eastern side of the valley is composed of the Silurian strata which prevail in East Tennessee [Knox dolomite] and is covered by the limestone which is found in Middle Tennessee, [Ordovicic limestone] so that the junction of the two divisions takes place in this valley and continues below the Cumberland Mountains.

The country west of the Cumberland Mountains as far as the Tennessee River, known under the name of Middle Tennessee, is generally composed of Silurian [Ordovicic] limestone which is here and there covered by Carboniferous and Devonian Strata. Most of my observations being made before I was acquainted with the labours of Mr. Murchison, I can not give an accurate limitation of the Devonian and Carboniferous deposits, so that some of the Crinoids which are put down as occurring in the Carboniferous strata may belong to the Devonian deposits. The Middle Tennessee rocks terminate at the Tennessee River. At a few places they cross this river, as in Decatur County. Nevertheless this river forms generally the western limit of the Paleozoic Strata in Tennessee.

West of the Tennessee River, as far as the Mississippi which forms the western boundary of the State of Tennessee, the Cretaceous strata prevail. [See above p. 4]. They are composed of marl, green sand and argileaces strata, the first [Selma clay] characterized by *Exogyra costata, Gryphaea convexa* and several species of *Ostrea*—the second (green sand) by *Hamites* and *Ptychoceras*, and the third [Ripley formation] by siliceous wood and lignite.

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[a] Clinch Mountain is composed of Ordovicic and Siluric strata ranging in age from the Knox dolomite to the Rockwood formation, while the strata of the Bay's Mountain region are Cambric and Ordovicic, in age ranging from the Athens shale to the Bays sandstone.—E. W.

[b] The formations east of the Cumberland escarpment have been mapped by the U. S. Geological Survey as the Knox dolomite and the Chickamauga limestone.—E. W.

A few of the Crinoids described in this Monograph were found on the Cumberland Mountains and in East Tennessee, but the generality were discovered in Middle Tennessee, including Decatur County which lies west of the Tennessee River.

Before terminating this introductory I must acknowledge my sincere thanks to my friend Major A. Heiman who has drawn all the figures, and as appears from the work itself, in a superior manner.

I have also to request the indulgence of the reader,—having been attacked by a serious malady which has lasted more than 6 or 7 months whilst I was preparing it [the Monograph] for the press; my memory and sight were more or less impaired, by which many inaccuracies and mistakes may have been produced.

DESCRIPTION OF SPECIES.

Class CYSTOIDEA Jaekel.

Order DICHOPORITA Jaekel.

A. REGULARIA Jaekel.

Family CHIROCRINIDÆ Jaekel.

Genus CHIROCRINUS Eichwald.

CHIROCRINUS ANGULATUS, new species.

Plate 8, figs. 9, 10.

Cyathocrinites sculptus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850 (*nomen nudum*); MSS., 1850.

Cyathocrinus sculptus Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 149 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 236 (catalogue name).

The original description by Troost is as follows:

It resembles more or less *C. geometricus* of Goldfuss (Tab. LVIII, fig. 5.) in its general appearance, and the stellated figures on the surface are similar. Its pelvic [infrabasal] plates are different, the superior angle being more acute gives a hexangular form to the costals [basals], which are pentagonal in the *C. geometricus*. The insertion of the column differs also—in the *C. sculptus* a deep, large, subquadrangular cavity receives a cylindrical column, this cavity occupies about one half of the diameter of the body. The superior rim being somewhat injured, the place for the arms and its superstructure can not be determined.

Discovered in Knox County, East Tennessee, Silurian.

Supplementary description.—Basals four, bent abruptly upward for nearly half their length to form the sides of a quadrilateral basal excavation; second range of plates apparently five, three hexagonal, one pentagonal, and the fifth not preserved; of the third range of plates only two, and fragments of two more, plates are preserved. The posterior side shows only fragments of plates.

Numbering the plates as suggested by Jaekel [1899] pectinirhombs are present on plates B2 to B1, B2 to B3, B2 to L1, B2 to L2, also on plates L1 to L′2 and L2 to L′2.

Stereom thrown into strong folds passing from the center of each plate across the sutures to the centers of all adjacent plates, and forming prominent triangular figures. On parts of the surface finer ridges connect the angles of the large triangle with those of a smaller one within it.

Column made up of transversely ridged plates with a very large lumen.

Observations.—From the small number of plates preserved and the regularity of their arrangement it is not surprising that Troost mistook this specimen for a crinoid.

The surface ridges resemble those of *Chirocrinus striatus* from the "Lower Silurian" of Russia, but it is a smaller species with relatively shorter and wider plates.

The specific name *sculptus* having been used by Schmidt for an European species of *Chirocrinus*, a new designation for the American species becomes necessary.

Formation and locality.—Although Troost's locality reference is rather indefinite, the type-specimen was found undoubtedly in the Middle Ordovicic shales associated with the marbles in the vicinity of Knoxville, Tenn.

Cat. No. 39951, U.S.N.M.

Family CALLOCYSTIDÆ Bernard.

Genus TETRACYSTIS Schuchert.

Tetracystis Schuchert, Smithsonian Misc. Coll., XLVII, 1904, Pt. 2, p. 217.

TETRACYSTIS FENESTRATUS (Troost) Schuchert.

Echinocrinites fenestratus Troost, Amer. Journ. Sci., (2), VIII, 1849, p. 419 (*nomen nudum*).

Echino-encrinites fenestratus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.—Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 368 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 241 (catalogue name).

Tetracystis fenestratus Schuchert, Smithsonian Misc. Coll., XLVII, 1904, p. 219, text fig. 26, pl. xxxiv, figs. 6–8.

The following is quoted from Troost's original description:

Echino-encrinites fenestratus, mihi.

This crinoid, the summit of which is closed, and which does not possess arms, approached to the genus *Echino-encrinites* of Herman von Meyer—*Cystides* of von Buch, but it differs nevertheless in very important particulars from *Echino-encrinites*. The arrangement and number of plates of which it is composed are perhaps identical with those of *Echino-encrinites*. I say perhaps, because the five plates which form the summit, as will be seen, can not be distinguished in our fossil. The other characters by which it differs from the *Echino-encrinites* may entitle it to form a new genus.

It has the form of a small acorn; four furrows [ambulacra [a]] running longitudinally from the summit to the base, divide the surface into four equal parts; on three of them

[a] Additions to this description, inclosed in brackets, are by Professor Schuchert.—E. W.

are poriferous rhombs and on one is an oval aperture [anus]. The poriferous rhombs are barred (these bars are not equal in number in these rhombs; some have 16, and 14 at the top, and 12 below) in the direction of the smaller diagonal which gives them the appearance of venetian blinds, from which its specific name.

The pelvis is circular with four reëntering angles, composed of four [basal] plates, three of which are pentagonal, and one, having its superior angle truncated, is hexagonal. The lower part of the pelvis terminates externally in a more or less projecting edge and then the plates turning immediately inwards form the sides of a [deep] circular excavation in which the column was inserted.

The first [second] series of plates is composed of five; four are hexagonal, and one having upon its lower margin one [i. e., one-half] of the poriferous rhombs is rendered thereby irregular. They are placed in the four reëntering angles of the pelvis; the fifth plate is quadrilateral and rests upon the hexagonal pelvic plate, the superior of which surrounding partly the oral aperture [anus] is also thereby rendered irregular.

The second [third] series is composed of five hexagonal plates of which three are rendered irregular by two poriferous rhombs and by the oral aperture [anus]. This oral aperture is large and circular. One of the poriferous rhombs, on the quarter section on the left of the oral aperture, occupies about one-half of an hexagonal plate; above this rhomb is an elevation, running transversely and having on its summit a furrow [the madreporite], and below it a single pore [the hydropore], neither of which penetrates through or deeply into the plate. The second poriferous rhomb is on the quarter section on the right of the oral aperture; it occupies the upper part of the third hexagonal plate, which is thus also rendered irregular.

The summit, which has no aperture, as in other species of this genus, may have been composed of five plates. But our fossil, which is very perfect, without the least erosion, being around the summit much complicated by the [ambulacral open] furrows mentioned above, which here combine, the joints of the plates being thereby obliterated, their number and form can not be ascertained.

I can say nothing about the column,—the place where I found my specimen contained numerous fragments of different crinoids. The place of insertion of the column is very large in proportion to the size of the body, its diameter being 4 mm., while the largest diameter of the body is 10 mm. and the length 14 mm. The column was not inserted as is generally the case with crinoids. The cavity is formed of an inclined slope or bevel of about 2 mm., having no articulating striae.

I found this interesting fossil in Decatur county, Tennessee, associated with *Calymene Blumenbachii* [=*C. niagarensis*], *Orthoceratites*, *Tereb. wilsoni* [=? *Wilsonia saffordi*], etc.

Professor Schuchert [1904, pp. 220–222] comments on this species as follows:

Remarks.—It is interesting to find that Troost had a species of *Tetracystis* more than 50 years ago, which he then referred to *Echino-encrinites*. It is closely related to the Manlius *T. chrysalis*, but differs in being smaller, more circular in transverse outline, and not flattened as is that species; the pectinirhombs, also, have far fewer dichopores. In *T. fenestratus* there are 12 to 17 pores, and in *T. chrysalis* from 25 to 35. Of brachioles the former has from 7 to 8 on each side of an ambulacrum, while the latter species has 11 in the same space. Plate 19 and deltoid 24 may not be present in *T. fenestratus;* if they are, they are now obscured by the ambulacralia. However, as Troost's species is otherwise closely related to *T. chrysalis*, it is probable that other specimens may reveal these two small plates.

Formation and locality.—The horizon in Decatur County, Tennessee, furnishing this fossil, appears to be the Brownsport limestone of Foerste, formerly a part of Safford's Meniscus limestone, in the upper portion of the Niagaran.

Cat. No. 35091, U.S.N.M.

B. IRREGULARIA Jaekel.

Family CARYOCRINIDÆ Bernard.

Genus CARYOCRINUS Say.

Troost described five species of *Caryocrinus* from Decatur County, Tennessee. All of the specimens are missing; and the following synonymy is worked out from the descriptions and figures, all of which are reproduced. It is possible that with the original specimens a different grouping would be made, but the following appeals to the writer as the best that can be done with the available material.

CARYOCRINUS MILLIGANI Miller and Gurley.

Plate 2, figs. 3 to 9.

Caryocrinites meconideus Troost, Proc. Amer. Ass. Adv. Sci., II, 1850, p. 60 (*nomen nudum*).

Caryocrinites granulatus Troost, Proc. Amer. Ass. Adv. Sci., II, 1850, p. 60 (*nomen nudum*).

Caryocrinites insculptus Troost, Proc. Amer. Ass. Adv. Sci., II, 1850, p. 60 (*nomen nudum*).

Caryocrinus ornatus Roemer, Sil. Fauna westl. Tenn., 1860, p. 33, pl. III, figs. 1*a*, *b*, *c*.

Caryocrinus milliganæ Miller and Gurley, Bull. No. 9, Illinois State Mus. Nat. Hist., 1896, p. 63, pl. v, figs. 3, 4.

Caryocrinus roemeri Jaekel, Stammes-geschichte der Pelmatozoen, Berlin, I, 1899, p. 314, pl. XVII, figs. 3, 3*a*.

The following is the original description by Troost:

It differs principally from the *Caryocrinites ornatus* of Say in being more elongated and in having a triangular capital integument; the oral [anal] aperture is lower in the *meconidcus* [*milligani*] than it is in the *ornatus*—it pierces the scapulars [radials] and does not rest upon the superior angle as is mentioned by Mr. Say respecting the *C. ornatus*.

Say says the longitudinal diameter is from three quarters to one inch and a half, the transverse from seven tenths to one inch and two fifths. I have specimens which are about three inches longitudinally and two and one fifth inches transversely.

In superficial configuration and in other respects it coincides with the *C. ornatus*.

It occurs in Decatur County, Tennessee, associated with *Calceola*, *Eucalyptocrinites*, *Cupellocrinites* [*Marsipocrinus*], etc.

According to the figures of Miller and Gurley [1896 (April), pl. 5, figs. 3, 4], the anal aperture cuts the upper edge of the radials, but is not wholly within them.

Of the form to which Troost has given the name *Caryocrinites granulatus*, he says:

This species differs from the *meconideus* [*milligani*] chiefly by having a granulated surface.

Decatur County.

The following is Troost's description of *Caryocrinites insculptus:*

The general form is the same as that of the *C. meconideus* [*milligani*] but the surface is adorned with projecting ridges which proceed from the center of the plates;

they are not formed of pores as in the preceding species, and whereas in that species five and six series of pores proceed from the center of the plates, in the *C. insculptus*, only four elevated ridges proceed from the center.

Decatur County.

The difference in surface between Troost's *C. meconideus* and his *C. granulatus* and *C. insculptus* may be accounted for by the former having been apparently an exfoliated specimen. The form described as *C. insculptus* was probably a young individual, which might account for the smaller number of radiating ridges on the plates. The differences brought out by Troost's descriptions and figures of these three specimens seem insufficient to separate them as distinct species. They are therefore united under the name of an apparently identical species described by Miller and Gurley [1896 (April), p. 63].

Formation and locality.—Brownsport limestone. It occurs in Decatur County, Tennessee.

Cat. Nos. 39904, 39905, U.S.N.M.

CARYOCRINUS GLOBOSUS Troost.

Plate 2, fig. 1.

Caryocrinites globosus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Caryocrinus globosus SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, p. 351 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 231 (catalogue name).

The original description by Troost is as follows:

Distinguished by its globular form, flat pelvis, and capital integument which hardly projects above the general surface of the body.

The figure of this species resembles in general outline, one of Roemer's figures [1860, pl. 3, fig. 1*a*] of *C. ornatus*, now referred to *C. milligani*, but it has a less elongate base and apparently a smaller tegmen.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39907, U.S.N.M.

CARYOCRINUS BULBULUS Miller and Gurley.

Plate 2, fig. 2.

Caryocrinites hexagonus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Caryocrinus hexagonus SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, p. 359 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 231 (catalogue name).

Caryocrinus bulbulus MILLER and GURLEY, Bull. No. 5, Illinois State Mus. Nat. Hist., 1894, p. 11, pl. II, figs. 15, 16, 18, 19.

The original description by Troost is as follows:

It is distinguished from the *C. meconideus* [*milligani*] by the form of the costals [basals] which are in the *C. hexagonus* more elevated in their center which give to the

transverse section a hexagonal form. They are also deficient in the superficial ornamental lines and pores as in the *C. ornatus* and *meconideus;* at least not the least traces of these ornaments are visible upon the seven specimens in my collection.

The figures of Miller and Gurley show a node in the center of each radial rather than an angular elevation of its center, but this difference is too slight to be of specific value.

Formation and locality.—In a recent paper by Pate and Bassler [1908] the Brownsport limestone of Foerste is subdivided into the Beech River, Bob, and Lobelville formations, and *Caryocrinus bulbulus* is referred by them to the middle or Troostocrinus zone of the Beech River formation. Decatur County, Tennessee.

Cat. No. 39906, U.S.N.M.

Class BLASTOIDEA[a] Say.

Family PENTREMITIDÆ Etheridge and Carpenter (emend Bather).

Genus PENTREMITES Say.

The following remarks are by Troost:

The Genus *Pentremites* established by our countryman Thomas Say, and on which I wrote a memoir (Trans. of the geol. Soc. of Penn. vol. I pag. 224.) is so well known that it requires merely a short notice of how the several species differ from one another; and as to my knowledge, no good figures have been published of the American *Pentremites*, I offer here accurate representations of the *Pentremites* that occur in the State of Tennessee with which those that I have seen in the States of Missouri, Illinois, Kentucky and Alabama correspond.

Some of the species of this genus are very abundant in certain parts of the Western States, while others are scarce. A division of the Carboniferous limestone is particularly characterized by *Pentremites*. I possess a slab of such Pentremital limestone which has a surface of about 236 square inches; on this surface are 120 *Pentremites*, of all sizes, from 4/5 to 1/10 of an inch in length; and, judging from the sides of the slab, the whole of it seems to be made up of an accumulation of these fossils. They, being siliceous, have withstood the decomposing action of the atmosphere which has dissolved the limestone, so that the fossils stand out in prominent relief, some for more than two thirds of their diameter. It contains few other fossils; on the whole slab I find only one *Terebratula*, two other bivalves and *Cyathophilla*, so that these seas must have swarmed at that period with *Pentremites*.

Whether the species which I here describe must be considered as true species or as mere varieties, I leave others to decide. I only mention that the Pentremites here described inhabited different localities; the *pyriformis* occupies the lowest strata of the Carboniferous series. The *globosus*, *florialis* and the *florialis elongata*, are found in a higher situation. In Alabama in some places the pentremitic stratum is in contact with the coal. The *P. cherockee* is very rare; I found it only in one place

[a] The Blastoidea of the Troost collection were referred to Dr. Gustav Hambach for revision, and the results of his work appeared in the Trans. Acad. Sci. St. Louis, XIII, pp. 1-67. As the specimens described by Troost are not in the possession of the writer, with the exception of *Nucleocrinus globosus*, Doctor Hambach's work is followed without change except in a return to names which appear to have priority as noted in the text. The synonymy is also added by the present writer.

on the left bank of the Tennessee River. I found in the Silurian strata only one species, the *P. reinwardtii*, which is very distinct from all other species of Tennessee *Pentremites*.

PENTREMITES GODONI (Defrance).

Plate 3, fig. 5.

Kentucky Asterial Fossil PARKINSON, Org. Rem. of a former World, 1808, p. 235, pl. XIII, figs. 36, 37.

Encrina godoni DEFRANCE, Dict. Sci. Nat., XIV, 1819, p. 467.

Pentremites globosa CHRISTY, Letters on Geol., 1848, pl. IV, figs. 7, 8.

Pentremites globosus TROOST, MSS., 1850.

Pentremites godoni SHUMARD, Trans. Acad. Sci. St. Louis, I, 1858, p. 245.—HALL, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 692, pl. XXV, figs. 13 *a*, *b*.—SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, p. 384 (catalogue name).—BILLINGS, Amer. Journ. Sci., XLVIII, 1869, p. 81, fig. 13.—WHITE, 2nd Ann. Rep. Dep. Stat. and Geol. Indiana, 1881, p. 511, pl. VII, figs. 10, 11.—ETHERIDGE and CARPENTER, Cat. Blastoidea, 1886, p. 157, pl. I, fig. 11; pl. II, figs. 1–13; pl. XII, figs. 16–17; pl. XVI, figs. 19, 22, 23.—MILLER, North Amer. Geol. and Pal., 1889, p. 268 (catalogue name).—KEYES, Missouri Geol. Surv., IV, 1894, p. 136.—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 414 (catalogue name).—BATHER, List Blastoidea Brit. Mus. (Nat. Hist.), 1899, p. 45 (catalogue name).—HAMBACH, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 38, pl. III, fig. 18.

The following is Troost's description:

Subspherical, vertically more or less flattened, base slightly pentagonal. Ambulacra reaching to the base, fields of ambulacra slightly longitudinally curved, column slender.

Occurs (not abundant) near Sparta at the ascent of the Cumberland Mountain, Craborchard Mountain in Bledsoe County, Tennessee; very abundant near Huntsville, at Mount Sano, Alabama—Illinois and Kentucky.

Observations.—This species has long been considered synonymous with *P. florealis*, but Doctor Hambach separates the two species. He says:

Shumard and many later authors confound this species with *Pentremites godoni*, which is a sad mistake because there is a considerable difference between these two species. In the typical *P. florealis* the body is more elongated, the base portion drawn out and more prolonged than in *Pentremites godoni*, and the plications of the ambulacral integument are coarser than in *P. godoni*. The typical *Pentremites florealis* is comparatively rare in Alabama and Kentucky but not so at Chester, Illinois, where *Pentremites godoni* does not occur at all. We find it again at Waterloo, Illinois, associated with *Pentremites florealis*, but it is by far the predominating species here.

Cat. No. 33069, U.S.N.M.

PENTREMITES PYRIFORMIS Say.

Plate 2, figs. 13, 14, 15.

Pentremites pyriformis SAY, Journ. Acad. Nat. Sci. Phila., 1st. ser., IV, 1825, p. 294; Zool. Journ., II, 1825, p. 314.—TROOST, Trans. Geol. Soc. Pennsylvania, I, Pt. 2, 1835, p. 228, pl. X, fig. 8.—OWEN, Amer. Journ. Sci., 1st. ser., XLIII, 1842, p. 20, fig. 3.—CHRISTY, Letters on Geol., 1848, pl. IV, fig. 6.—TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (catalogue name).—HALL, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 693,

pl. XXV, fig. 16.—Billings, Geol. Surv. Canada, Dec. IV, 1859, p. 20, figs. 5, 7.—Dujardin and Hupé, Hist. Nat. Zooph. Ech., 1862, p. 91.—Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 385 (catalogue name).—Billings, Amer. Journ. Sci., 3d ser., I, 1870, p. 228.—Wachsmuth and Springer, Proc. Acad. Nat. Sci. Phila., 1879, pl. XVII, fig. 5.—White, 2nd Ann. Rep. Dep. Stat. and Geol. Indiana, 1881, p. 511, pl. I, fig. 9.—Etheridge and Carpenter, Cat. Blastoidea, 1886, p. 167, pl. I, figs. 6, 7; pl. II, figs. 24-30; pl. XII, figs. 13, 15; pl. XVIII, fig. 3.—Miller, North Amer. Geol. and Pal., 1889, p. 268 (catalogue name).—Keyes, Missouri Geol. Surv., IV, 1894, p. 135.—Harris, Bull. Amer. Pal., I, No. 5, 1896, p. 352.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 416 (catalogue name).—Bather, List Blastoidea Brit. Mus. (Nat Hist.), 1899, p. 51 (catalogue name).—Hambach, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 38, pl. III, figs. 8, 9, 15, 16.

Pentatrematites pyriformis Roemer, Archiv. f. Naturg., Jahrg. XVII, I, 1851, p. 354, pl. V, fig. 9*a-c*.

Pentremites subconoideus Meek, U. S. Geol. Surv. Montana, Idaho, Wyoming and Utah, 1873, p. 471.

The following is the description by Troost:

Elongated elliptical.

Ambulacra long, reaching to the middle of the whole body—terminating at the base, acute pentagonal.

Western declivity of the Cumberland Mountain in an oolitic limestone.—Sequatchie Valley, Tennessee. Rarely Mount Sano, Alabama, and Springfield, Kentucky.

Observations.—Doctor Hambach does not mention the specimen which Troost has referred to this species, but according to the figures it appears to be correctly identified. The deltoids are longer than is usual in the species, but this point is not mentioned in the original description, and specimens subsequently referred to the species show great variation in the length of the deltoids.

Doctor Hambach distinguishes the species from *P. florealis* as follows:

This species differs from *P. florealis*, its nearest relative, in having its greatest diameter at the apex of the ambulacrum, dividing the calyx into two equal halves, i. e., the distance from the articulation surface of the column equals the distance from the apex of the ambulacrum to the summit.

Cat. No. 33073, U.S.N.M.

PENTREMITES ELEGANS Lyon.

Plate 2, figs. 10, 11, 12.

Pentremites tennesseæ Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS. 1850.

Pentremites elegans Lyon, Trans. Acad. Sci. St. Louis, I, 1858, p. 632, pl. XX, figs. 4*a-c*.—Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 383 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 267 (catalogue name).—Whitfield, Ann. N. Y. Acad. Sci., 1891, p. 577, pl. XIII, fig. 4; Geol. Surv. Ohio, VII, 1895, p. 466, pl. IX, fig. 4.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 413 (catalogue name).—Bather, List Blastoidea Brit. Mus. (Nat. Hist.), 1899, p. 43.—Hambach, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 37.

The following is the original description by Troost:

They differ principally from the *P. pyriformis* in having the ambulacra very short—their diameter in proportion larger.

Sequachie Valley and Sparta, Tennessee; Mount Sano, Alabama.

In reference to Troost's specimen Doctor Hambach says:

This species is synonymous with the one designated by Doctor Troost as *tennesseæ*, *nom. nud.* The description of Troost was never published.

Cat. No. 33072, U.S.N.M.

PENTREMITES FLOREALIS Say.

Plate 3, fig. 1.

Encrinites florealis Von Schlotheim, Petrefactenkunde, II, 1820, p. 38.

Pentremites florealis Say, Journ. Acad. Nat. Sci. Phila. (1), IV, 1825, p. 295.—Sowerby, Zool. Journ., II, No. 7, 1825, p. 314, pl. xi, fig. 2.—Goldfuss, Petrefacta Germaniae, Pt. 1, 1826, p. 181, pl. l, figs. 2*a–c*.—Troost, Trans. Geol. Soc. Pennsylvania, I, Pt. 2, 1835, p. 229, pl. x, fig. 3; Proc. Amer. Assoc. Adv. Sci., II (read 1849), 1850, p. 60 (catalogue name).—Owen and Shumard, Geol. Rep. Wisconsin, Iowa and Minnesota, 1852, p. 592.—Shumard, Marcy's Expl. Red Riv. Louisiana, 1854, p. 174.—Dujardin and Hupé, Hist. Nat. Zooph. Ech., 1862, p. 90.—Harris, Bull. Amer. Pal., I, 1896, p. 353.—Hambach, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 37, text fig. 12c.

Pentremites florealis var. *elongatus* Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (catalogue name).

Pentatrematites florealis Roemer, Archiv. f. Naturg., Jahrg. XVII, I, 1851, p. 353, pl. iv, figs. 1–4; pl. v, fig. 8.

Pentremites symmetricus Hall, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 694, pl. xxv, fig. 14.

Pentatrematites florealis Bronn, Klassen and Ordn. Their-Reichs., II, 1860, pl. xxiii, figs. 1*a–e*.

Pentremites godoni Shumard (in part), Trans. Acad. Sci. St. Louis, II, 1866, p. 384 (catalogue name).

Pentremites tennesseae Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 386 (catalogue name).

Pentremites godoni Weller (in part), Bull. No. 153, U. S. Geol. Surv., 1898, p. 414.

Pentremites godoni var. *florealis* Bather, List Blastoidea, Brit. Mus. (Nat. Hist.), 1899, p. 47 (catalogue name).

Pentremites altus Rowley, in Green's Contr. Indiana Pal., Pt. 8, 1901, p. 64, pl. xxiii, figs. 1, 2, 3.

The original descriptions of *Pentremites florealis* and *P. florealis elongatus*, by Troost, are as follows:

Pentremites florealis.

Elliptical—ambulacra long.—Pelvic plates short. They are sometimes very large, the largest that I have seen is in my collection and is 2½ inches long.

Not abundant, in the oolitic limestone near Sparta, Tennessee—very abundant at Mount Sano, Alabama, and Russelville, Kentucky.

Pentremites florialis elongatus, varietas.

It is constantly proportionately more elongated than the *P. florealis* of any of the other localities.

Eastern declivity of Cumberland Mountains, Morgan County. And it characterizes particularly the siliceous stratum in which the plates of the *Melonites* in Stewart County, Tennessee, are found.

Observations.—This species is separated from *P. godoni* by Hambach on account of the more elongate base (see p. 13), and from *P. pyriformis* in having the greatest diameter below the center as noted in connection with the latter species (see p. 14).

The variety *elongatus* is separated only on account of its more elongate form, but the individuals of the species show so much variation in proportional length that it seems inadvisable to establish a variety on this feature alone, in the absence of a figure or more detailed description.

The *Pentremites godoni* var. *florealis* of Etheridge and Carpenter [1886, p. 160] is separated from *P. godoni* as a variety "in which the bodies of the radials are very much inclined to the vertical axis of the calyx." It is thus quite different from *P. florealis* as defined by Hambach, and, as shown by the figure,[a] is closely allied to *P. godoni*.

Cat. No. 35070, U.S.N.M.

PENTREMITES SULCATUS Roemer.

Plate 3, figs. 14, 15, 16.

Pentremites cherokeus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.—Hall, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 691, pl. xxv, figs. 12*a*, *b*.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 412 (catalogue name).

Pentremites laterniformis Owen and Shumard, Journ. Acad. Nat. Sci. Phila. (2), II, 1850, p. 66, pl. vii, fig. 15.

Pentatrematites sulcatus Roemer, Archiv. fur Naturg., Jahrg. XVII, I, 1851, p. 354, pl. vi, figs. 10*a*, *c*.

Pentremites sulcatus Shumard, Marcy's Expl. Red Riv. Louisiana, 1854, p. 174; Trans. Acad. Sci. St. Louis, I, No. 2, 1858, pp. 243, 246; II, 1866, p. 385 (catalogue name).—Lyon and Casseday, Proc. Amer. Acad. Sci., IV, 1860, p. 298.—Bronn, Klassen und Ordn. Their-Reichs., II, 1860, pl. xxiii, figs. 1*f–j*.—Dujardin and Hupé, Hist. Nat. Zooph. Ech., 1862, p. 91.—Etheridge and Carpenter, Cat. Blastoidea, 1886, p. 165, pl. i, figs. 8–10; pl. ii, fig. 31; pl. xvi, fig. 20; pl. xviii, fig. 5.—Keyes, Missouri Geol. Surv., IV, 1894, pl. xviii, figs. 6*a*, *b*.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 416 (catalogue name).—Bather, List Blastoidea Brit. Mus. (Nat. Hist.), 1899, p. 54 (catalogue name).—Hambach, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 39, pl. vi, figs. 1–12.

Pentatrematites sulcatus Roemer, Bronn's Lethaea Geognostica, 3rd ed., Pt. 2, 1852–54, p. 282, pl. iv, figs. 9*a*, *b*.

Pentremites robustus Lyon, Trans. Acad. Sci. St. Louis, I, 1860, p. 629.

The following is the original description by Troost:

Transversely pentagonal, longitudinally pyramidal, the plates inclosing the ambulacra longitudinally deeply excavated and bent outwardly near the summit. Ambulacra long, reaching the pelvic plates—Pelvis very short.

On the base of the Look-out Mountain, Cherokee County, Tennessee.

Observations.—This species was described by Hall under the name of *Pentremites cherokeeus*, with *P. sulcatus* Roemer cited as a synonym.

[a] Etheridge and Carpenter Catalogue of the Blastoidea, pl. 2, fig. 3.

He gives no reason for proposing a new name for that already established by Roemer.

Family TROOSTOCRINIDÆ Bather.

Genus TROOSTOCRINUS Shumard.

Troosticrinus SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, p. 384, footnote.

Troostocrinus MEEK and WORTHEN (in part), Proc. Acad. Nat. Sci. Phila., 1868, p. 356; Rep. Geol. Surv., Illinois, V, 1873, p. 507.—ETHERIDGE and CARPENTER (in part), Ann. and Mag. Nat. Hist., IX, 1882, p. 247; Cat. Blastoidea, 1886, p. 191.—MILLER, North Amer. Geol. and Pal., 1889, p. 287.—ZITTEL, Text-Book Pal. (Eastman trans.), 1896, p. 195.—BATHER, List Blastoidea Brit. Mus. (Nat. Hist.), 1899, p. 68 (catalogue name); A Treatise on Zool., III, The Echinoderma, 1900, p. 92.

Clavæblastus HAMBACH, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 44.

In his proposed new classification Hambach states that "All names ending in 'crinus' are omitted," and he proposes the name *Clavaeblastus* to include *Troostocrinus reinwardtii*, the type of Shumard's genus *Troostocrinus*, and other similar forms. The change of a name merely on account of inappropriateness of form is not in accord with the accepted rules of nomenclature, and the genus *Troostocrinus* being defined and well established in the literature should stand.

TROOSTOCRINUS REINWARDTII (Troost).

Plate 3, figs. 2, 3, 4.

Pentremites reinwardtii TROOST, Trans. Geol. Soc. Pennsylvania, I, Pt. 2, 1835, p. 224; 5th Rep. Geol. Tennessee, 1840, p. 58; 6th Rep. Geol. Tennessee, 1841, p. 14.—YANDELL and SHUMARD, Contr. Geol. Kentucky, 1847, p. 6.—ROEMER, Neues Jahrb. fur Min., 1848, p. 296.—TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (catalogue name); MSS., 1850.—YANDELL, Proc. Amer. Ass. Adv. Sci., 1851, p. 232.—DUJARDIN and HUPÉ, Hist. Nat. Zooph. Ech., 1862, p. 99.

Pentatrematites reinwardtii ROEMER, Archiv. f. Naturg., Jahrg. XVII, I, 1851, p. 372, pl. VI, fig. 12*a–c;* Sil. Fauna westl. Tennessee, 1860, pl. III, fig. 2*a–e.*

Pentatremites reinwardtii BRONN, Klassen und Ordn. Thier-Reichs., II, 1860, pl. XXIII, figs. 4*a, b.*

Troosticrinus reinwardtii SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, pp. 384, 385.

Troostocrinus reinwardtii ETHERIDGE and CARPENTER, Ann. and Mag. Nat. Hist., IX, 1882, p. 249; Cat. Blastoidea, 1886, p. 194, pl. XII, figs. 11, 12; pl. XVII, fig. 17; text-fig. VII.—MILLER North Amer. Geol. and Pal., 1889, p. 287 (catalogue name).—BATHER, List Blastoidea Brit. Mus. (Nat. Hist.), 1899, p. 68 (catalogue name).

Clavæbastus reinwardtii HAMBACH, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 44 (catalogue name).

The original description by Troost is as follows:

Elongated, inverted pyramidal. Ambulacra short, not composed as [in] the preceding species of uniform transverse grooves, but of oblique alternating devisions, having the pores remote from the margin of the Ambulacra.

It is the only species of the Tennessee *Pentremites* which belongs exclusively to the Silurean Strata.

Decatur County, Tennessee.

Formation and locality.—This species marks the middle, or Troostocrinus zone, of the Beech River formation of the Brownsport limestone, as defined by Pate and Bassler [1908].

Cat. No. 33071, U.S.N.M.

Family NUCLEOCRINIDÆ Bather.

Genus NUCLEOCRINUS Conrad.

Nucleocrinus Conrad, Journ. Acad. Nat. Sci. Phila., VIII, 1842, p. 280.—Lyon and Casseday, Proc. Amer. Acad., IV, 1859, p. 295.—Hall, 15th Ann. Rep. New York State Cab. Nat. Hist., 1862, pp. 144, 146.—Meek and Worthen, Rep. Geol. Surv. Illinois, II, 1866, p. 275.—Billings, Amer. Journ. Sci. (3), I, 1870, p. 229.—Miller, North Amer. Geol. and Pal., 1889, p. 262.—Bather, List Blastoidea Brit. Mus. (Nat. Hist.), 1899, p. 21 (catalogue name); A Treatise on Zool., III, The Echinoderma, 1900, p. 88.

Olivanites Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850; Amer. Journ. Sci. (2d ser.), VIII, 1849, p. 419.—Hambach, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 48.

Elacacrinus Roemer, Archiv. f. Naturg., Jahrg. XVII, I, 1851, p. 375; Bronn's Lethaea Geogn., 3rd ed., Pt. 2, 1852–54, p. 283.—Dujardin and Hupé, Hist. Nat. Zooph. Ech., 1862, p. 100.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 1, 1862, p. 111; II, No. 2, 1866, p. 368.—Etheridge and Carpenter, Ann. and Mag. Nat. Hist., XI, 1883, p. 228; Cat. Blastoidea Brit. Mus., 1886, p. 210.—Zittel, Textbook Pal. (Eastman trans.), 1896, p. 195.

The original description by Troost is as follows:

When I first saw this fossil, it being partly imbedded in limestone, I considered it as a species of *Pentremites*, having five double rows of pores, and five double apertures at the summit like the *Pentremites*. I conjectured nevertheless that the lower part of the animal, the place of insertion of a column, and the plates composing the pelvis [base] differ from those of the genus *Pentremites*. The specimens then in my possession did not allow me to decide this point. I think it necessary to mention this as the fossil is generally known, on my authority, (though I did not publish a description of it) as a *Pentremites*. Having since got possession of perfect specimens, I have found out my mistake. I am now convinced that it is not supported by a column, consequently it constitutes a new genus, to which from the analogy of its form with that of an olive, I have given the name of *Olivanites*.

NUCLEOCRINUS VERNEUILI (Troost).

Plate 3, figs. 7, 8, 9, 10, 11, 12, 13.

Pentremites verneuili Troost, 6th Rep. Geol. State Tennessee, 1841, p. 14.—D'Orbigny, Prod. de Pal. Strat., I, 1849, p. 102.—Shumard, Trans. Acad. Sci. St. Louis, I, No. 2, 1858, p. 247.

Olivanites verneuili Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (catalogue name); MSS., 1850.—Lyon, Rep. Geol. Surv. Kentucky, III, 1857, p. 487, pl. v, figs. 1*a–d*.

Elacacrinus verneuili Roemer, Archiv. f. Naturg., Jahrg. XVII, I, 1851, p. 379, pl. viii, figs. 1*a–d;* Bronn's Lethaea Geognostica, 3d ed., Pt. 2, 1852–54,

p. 284, pl. IV, figs. 10*a–b*.—BRONN, Klassen und Ordn. Thier-Reichs, I, 1859, pl. XXIII, figs. 5*a–e*.—DUJARDIN and HUPÉ, Hist. Nat. Zooph. Ech., 1862, p. 100.—SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, p. 369 (catalogue name).—ETHERIDGE and CARPENTER, Ann. and Mag. Nat. Hist., IX, 1883, p. 231; Cat. Blastoidea Brit. Mus., 1886, p. 216.

Nucleocrinus verneuili LYON and CASSEDAY, Proc. Amer. Acad., IV, 1859, p. 295.—BILLINGS, Amer. Journ. Sci. (3), I, 1870, p. 229, figs 3–6.—MILLER, North Amer. Geol. and Pal., 1889, p. 263.—BATHER, List Blastoidea Brit. Mus. (Nat. Hist.), 1889, p. 22 (catalogue name); A Treatise on Zool., III, The Echinoderma, 1900, p. 88, text fig. X.

The original description by Troost is as follows:

Pelvis,—or the base of the body—is very complicated in the *Olivanites*. It is composed of five plates of an irregular form—each has a very elevated ridge running longitudinally over them, this elevated ridge is hollow at the superior margin, in the aperture of which it receives the lower extremity of the double rows of pores or what is generally called ambulacrum, these five plates, joined together have a subpentagonal form, each of the five angles being elevated and somewhat rounded to receive the five double rows of pores. Five such plates joined together leave a pentagonal vacuum in its center, and this open place, which I at first considered as a cavity in which a column was inserted, is closed up with numerous small plates forming a kind of mosaic placed at the bottom of the cavity.

Here the general arrangement of costals, and scapulars as in the generality of crinoids, terminates. The whole is now composed of a shell on which no suture of junction is perceptible. Consequently it does not belong to the *Prentremites* in which these divisions are found, and in which the pelvis is divisible into three parts.

Five double rows of pores, originating at the summit near two small elongated apertures, descending longitudinally terminate in the above mentioned cavity under the elevations of the pelvic plates. These two rows of pores are separated by a narrow strip, or septum, having a longitudinal depression in the middle, and must have answered for the same purpose as the ambulacra in the *Pentremites* which are also composed of double rows of pores.

The apertures near the origin of the ambulacra—or double rows of pores—form in the interior a short conical tube, descending a short distance and [it] is not closed—The place where the ambulacra terminate is also open in the interior.

The intermediate spaces between the ambulacra are superficially divided by longitudinal lines into five parts—the middle part is slightly elevated above the two others, and is more or less longitudinally grooved, while the two following are transversely striated. Four of these parts are of equal size—but the fifth is broader and its central part is much more elevated and wider than in the four other divisions, it reaches not the same height and has on its summit a large lanceolate aperture with an elevated border. Its summit is covered with numerous microscopic plates.

Some imperfect specimens were found in Bedford County, Tennessee. More perfect ones I found at the Falls of the Ohio River [Onondaga limestone].

Cat. No. 33075, U.S.N.M.

NUCLEOCRINUS GLOBOSUS (Troost).

Plate 3, fig. 6.

Olivanites globosus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850.—HAMBACH, Trans. Acad. Sci. St. Louis, XIII, 1903, p. 50 (catalogue name).

The following is the original description by Troost:

It differs from *O.* [*Nucleocrinus*] *verneuili* in being globular, and having no projecting ridges, nor are any transverse stria on the fields between the ambulacra, perceptible.

Bedford County, Tennessee.

Observations.—Doctor Troost's specimen is about three-fourths the height of *Nucleocrinus verneuili* and the interambulacral areas are wider than those of any of the specimens of the latter species with which it has been compared. The difference in height can hardly be due to compression, since the specimen has not the diameter necessary to account for such a decrease in height. The globular form, together with the wide ambulacral areas lead to the retention of Troost's species, at least until forms are found connecting it more closely with *Nucleocrinus verneuili*.

The method of preservation of *Nucleocrinus globosus* is the same as that of specimens of *N. verneuili* from the Falls of the Ohio, and they may be from the same locality, since Doctor Troost's records of localities were found, in a few instances, to be erroneous.

Cat. No. 33076, U.S.N.M.

Family ORBITREMITIDÆ Bather.

Genus ORBITREMITES Austin.

Orbitremites J. E. Gray, Synops. Contents Brit. Mus., 42nd ed., 1840, p. 63 (*nomen nudum*).—T. Austin and T. Austin, Jr., Ann. and Mag. Nat. Hist. (1), X, 1842, p. 111.—Bather, List Blastoidea Brit. Mus. (Nat. Hist.), 1899, p. 23; A Treatise on Zool., III, The Echinoderma, 1900, p. 90.

Granatocrinus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); Amer. Journ. Sci., 2d ed., VIII, 1849, p. 420.—Hall, 15th Rep. New York State Cab. Nat. Hist., 1862, p. 146.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 375.—Meek and Worthen, Rep. Geol. Surv. Illinois, II, 1866, p. 274.—Zittel, Handb. Pal., I, Pt. 3, 1879, p. 434.—Etheridge and Carpenter (in part), Ann. and Mag. Nat. Hist., IX., 1882, p. 236; Cat. Blastoidea, 1886, p. 238.—Miller, North Amer. Geol. and Pal., 1889, p. 250.

Elaeacrinus Shumard (in part), Trans. Acad. Sci. St. Louis, II, No. 1, 1863, p. 112.

Cidaroblastus Hambach, Trans. Acad. Sci. St. Louis, XIII, 1903, pp. 24–32, 45.

The original description by Troost is as follows:

This genus in some of its characters approaches *Olivanites* and *Pentremites*, having, like these genera, five double rows of pores. It is distinguished from the *Pentremites* by the absence of a column [a] and by being destitute of the five characteristic apertures upon which the generic name of *Pentremites* is founded; and from the *Olivanites* [by the absence] of the division of the fields between the ambulacra which in the *Granatocrinites* is composed of three plates, and which is not the case with the *Olivanites*.

[a] Hambach says that a surface for the articulation of a column is present on Troost's type.—E. W.

ORBITREMITES GRANULATUS (Roemer.)

Plate 4, figs. 12, 13, 14, 15, 16, 17.

Granatocrinites cidariformis TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS. 1850.

Granatocrinites globosus TROOST, MSS. 1850.

Pentatrematites granulatus ROEMER, Arch. Naturg., XVII, (1), 1851, pp. 363, 364.

Granatocrinus granulatus HALL, 15th Rep. N. Y. State Cab. Nat. Hist., 1862, p. 146.—SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, p. 375 (catalogue name).—ETHERIDGE and CARPENTER, Cat. Blastoidea, 1886, p. 244.—MILLER, North Amer. Geol. and Pal., 1889, p. 250 (catalogue name).—WELLER, Bull. No. 153, U. S. Geol. Survey, 1898, p. 299 (catalogue name).

Orbitremites? granulatus BATHER, List Blastoidea Brit. Mus. (Nat. Hist.), 1899, p. 29.

Cidaroblastus granulatus HAMBACH, Trans. Acad. Sci. St. Louis, XIII, 1903, pp. 27–32, 45.

The following is the original description of *Granatocrinites cidariformis* by Troost:

Globular, slightly elongated.

Pelvis [base] more or less stellated or pentagonal, composed of small plates, forming a small concave dome without any marks of insertion of a column [?] or of an appearance of an alimentary aperture [lumen].

The five plates which surround the pelvis are elongated, sub-pentagonal approaching in form similar plates in the *Pentremites*, their superior margin being circular and having a longitudinal incision which terminates near the base, where they form the margin of the pelvic cavity, and thence rising they enclose partly the double rows of pores which descend from the summit and terminate near the lower margin.

These five plates combined form a cup with five circular elevations at the rim, in the re-entering angles of which are placed five isosceles triangular plates being beveled at the base so as to fit the rounded margin of the inferior plates.

Five double rows of pores proceed from the very summit, running along the triangular plates above mentioned, and entering into the incision of lower series of plates first mentioned, terminate near the lower margin of them.

The whole surface is granulated—these grains have a tendency to run parallel to the sides of the plates.

No ovary or oral aperture, is visible on the surface; they may nevertheless have existed in the live state, and have been obliterated during fossilification, because judging from siliceous internal casts of the same, I think I perceive traces of such apertures.

They occur near Shelbyville, Bedford County, Devonian [Tullahoma formation]—and in Allen County, Kentucky.

The following is the original description of *Granatocrinites globosus* by Troost:

It differs from *G. cidariformis* in being globular, having at the base a circular cavity, the junction of the lower series of plates with those of the superior being curvilinear, and its surface being very irregularly granulated, whereas the *O. cidariformis* is oval, has a pentagonal basal cavity, the junction of the above mentioned place is rectilinear and its surface regularly granulated.

Bedford County, Tennessee.

Observations.—Doctor Hambach regards *Granatocrinites globosus* Troost as a synonym of *G. cidariformis*. In reference to Troost's

statement that the granules of the latter run parallel to the sides of the plates Hambach says: "This is an incorrect statement, because the specimen shows just the reverse."

Cat. Nos. 33077, 33080, U.S.N.M.

Class CRINOIDEA Miller.

Subclass MONOCYCLICA Bather.

Order MONOCYCLICA INADUNATA Bather (Wachsmuth and Springer, in part, emend.)

Family HETEROCRINIDÆ Zittel (emend. Wachsmuth and Springer).

Genus ECTENOCRINUS S. A. Miller.

ECTENOCRINUS CANADENSIS (Billings).

Plate 4, fig. 10.

Heterocrinites simplex Troost, Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (catalogue name); MSS., 1850.

Heterocrinus canadensis Billings, Can. Org. Remains, Dec. IV, 1859, p. 48, pl. XIV, figs. 5*a–d*.—Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 377 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, Pt. 3, 1886, p. 206 (catalogue name).

Heterocrinus simplex Wachsmuth and Springer, Rev. Palæocrinoidea, Pt. 1, 1879, p. 150 (catalogue name).

Ectenocrinus canadensis Miller, North Amer. Geol. and Pal., 1889, p. 242.

The following remarks are by Troost:

I found only a few mutilated specimens of this fossil in the Silurian strata in the State of Tennessee, but I collected some perfect ones in the State of Kentucky which were imbedded in a soft argillaceous limestone and I succeeded in developing some perfect heads which were affixed to about two inches of their column, and some others which were eroded in such a manner as to display their internal structure, from which it appears that in the *Heterocrinites* [*Ectenocrinus*] of Tennessee and Kentucky the coronal integument terminates in an articulated fluted proboscis, which ascends between the fingers [arms] to nearly where they terminate; and that the fingers [arms] are furnished with tentacula or feathers [pinnulae]. These facts are not mentioned by Hall [1847, p. 280]. Hall also mentions that the column is pentagonal, this also does not agree with the Tennessee fossil. On a slab of limestone similar to that above mentioned, which contains a great number of columns some of which are affixed to mutilated heads, not a single pentagonal column is found, they are all formed of small and large alternating circular joints with rounded margin, as is represented on the figure.

Observations.—Meek united provisionally the *Heterocrinus canadensis* Billings with his *Heterocrinus simplex* var. *grandis*, but wrote that his species differs from *H. canadensis* in its shorter and more wedge-shaped arm plates. For this reason it seems best to regard them as distinct species unless a comparison of the types should show them to be more nearly alike than the description indicates.

Troost's species has relatively long arm plates, and is more closely related to *Heterocrinus canadensis* than to Meek's variety, with which it corresponds in size.

Formation and locality.—Lower part of Trenton formation. Frankfort, Kentucky.

Cat. No. 39921, U.S.N.M.

Family PISOCRINIDÆ Angelin.

Genus PISOCRINUS de Koninck.

PISOCRINUS MILLIGANI Miller and Gurley.

Haplocrinites hemisphaericus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61, (*nomen nudum*).

Pisocrinus gorbyi MILLER (in part), 17th Rep., Indiana Geol. Nat. Res., 1892, p. 640, pl. VI, figs. 21, 22, 23.

Pisocrinus milligani MILLER and GURLEY, Bull. No. 7, Illinois State Mus. Nat. Hist., 1895, p. 80, pl. V, figs. 27, 28.

Troost referred this species to *Haplocrinus*, and his remarks merely distinguish the specimen from *Haplocrinus stellaris* Roemer and *H. mespiliformis* Goldfuss. His figures are misleading, as they represent a regular arrangement of suture lines which does not appear on the specimen.

The single specimen in the Troost collection represents the dorsal cup only, and the suture lines are not sufficiently distinct to show the arrangement of the plates, but in all the characteristics which appear it is identical with the *Pisocrinus milligani* of Miller and Gurley. On one of Miller and Gurley's figures, fig. 27, pl. 5, the shading is reversed. The fact that the mortise occurs on the projecting lobe of the radial in their specimen, as well as in that of Troost, is shown by their description, and by an earlier figure of Miller [1892, pl. 6, fig. 23].

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39941, U.S.N.M.

Family CATILLOCRINIDÆ Wachsmuth and Springer.

Genus CATILLOCRINUS Shumard.

Catillocrinites TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Catillocrinus SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 357.—MEEK and WORTHEN, Geol. Surv. Illinois, III, 1868, p. 465; V, 1873, p. 504.—ZITTEL, Handb. d. Pal., I, 1879, p. 348.—DE LORIOL, Palaeontologie Francaise, Crinoids, XI, 1882, p. 46.—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, III, 1885, p. 268.—MILLER, North Amer. Geol. and Pal., 1889, p. 231.—BATHER, A Treatise on Zool., III, The Echinoderma, 1900, p. 150.

Nematocrinus MEEK and WORTHEN, Proc. Acad. Nat. Sci. Phila., 1866, p. 251.

The following is Troost's original description:

Column cylindrical. Alimentary canal [lumen] pentagonal or penta-petalous.

Pelvis, [base] sub-pentagonal divided into 3 unequal parts.

Body, composed of four [five], irregularly shaped, externally convex pieces, forming, connected together, a hemispherical cup, with a broad border, having a tooth-like elevation on one side and on the opposite side a lanceolate depression.

Supplementary description.—The essential characteristics of the genus are as follows: Basals three, unequal, projecting beyond the column on the left anterior side. There are five dissimilar radials of which the anterior and left posterior radials are fan-shaped, much larger than the others, and bear numerous (15 to 31) arms each. The arms are unbranched and non-pinnulate. The right posterior radial bears a tooth on which the anal tube rests. No anal plate is present.

Genotype.—Catillocrinus tennesseeæ.

The first published description of the genus was by Shumard [1868, p. 357]. He described the calyx erroneously as made up of three series of plates, and assumed that the basal pieces were probably five in number. Wachsmuth and Springer [1886, p. 268] and Bather [1900, p. 150] describe the basal disk as undivided, but Troost's observation appears to be correct, as the suture lines between the plates show distinctly on one of the specimens, and traces of them appear on others.

CATILLOCRINUS TENNESSEEÆ (Shumard).

Plate 9, figs. 1, 2, 3.

Catillocrinites tennesseæ Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Catillocrinus tennesseeæ Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 358.—Wachsmuth and Springer, Rev. Palæocrinoidea., III, 1885, p. 272.—Miller, North Amer. Geol. and Pal., 1889, p. 231 (catalogue name).

The original description by Troost is as follows:

The plates which compose the body are—a pelvis [base] which is an irregular pentagon more or less concave, bearing a circular impression for a column which occupies almost the whole of the pelvis [base] and has an irregular pentagonal or pentapetalous aperture. The margins of the articulating surfaces of the column are notched. This pelvis supports two irregular semilunar plates and four [two] irregular pear-shaped plates of which one seems to be divided into two parts [i. e. five plates in all]. The superior border being irregularly circular, occupying more than half of the whole superior surface, is covered with radiating striae, somewhat like the articulating surfaces of the encrinital columns— These striae proceed from a series of pores near the external margin of the border and terminate partly in the abdominal cavity and partly on the border itself as is shown in the figure. The striae above mentioned are interrupted by a dental elevation. It is placed (the dental elevation) upon one of the divisions of the above mentioned divided pear-shaped plate. Opposite to this dental elevation and on the interior of the undivided pear-shaped plate is an aperture, or furrow, occupying the space only of one pore on the external margin, but then extending, inwards and downwards, assuming a heart-shaped figure in the abdominal cavity. (See fig. 1.) The external surface, the pelvis excepted, is finely granulated.

Observations.—The six specimens of this species in the Troost collection represent the dorsal cup only. The form and proportions of the

plates are shown by the figures. The dorsal cup is thin at the base but thickens rapidly upwards until the upper edge of the radials has a thickness of one-fourth the greatest diameter of the cup.

Formation and locality.—Found in the Knobstone shale at Buttonmould Knob, 7 miles south of Louisville, Kentucky.

Cat. No. 39911, U.S.N.M.

Family HAPLOCRINIDÆ Roemer.

Genus HAPLOCRINUS Steininger.

Five species are described as belonging to the genus *Haplocrinus*, but of these, specimens are missing for all but one. The latter, *H. hemisphericus* Troost, is apparently identical with *Pisocrinus milligani* Miller and Gurley.

The name *Haplocrinus steininger* is given to a specimen which Troost considered to be closely related to but specifically distinct from *H. mespiliformis* Goldfuss. As he does not say how his species differs from that of Goldfuss and gives no figure or description of it, it is impossible to determine to what form the name applies and it therefore becomes valueless.

The publication of the description and figures of the remaining three of Troost's species give them the same standing they would have had if published earlier and the discovery of similar specimens or comparison of the figures with specimens now in the hands of collectors may lead to a more accurate determination of their affinities than is now possible.

HAPLOCRINUS OVALIS Troost.

Plate 4, fig. 3.

Haplocrinites ovalis Troost, Proc. Amer. Ass. Adv. Sci. (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Haplocrinus ovalis Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 376 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1886, p. 159 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 252 (catalogue name).

The original description is as follows:

It differs from *Haplocrinus hemisphericus* [*Pisocrinus milligani* Miller and Gurley] in being more elongated, and transverse circular, whereas the *H. hemisphericus* is pentagonal and compressed.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

HAPLOCRINUS GRANULATUS Troost.

Plate 4, figs. 4, 5.

Haplocrinites granulatus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Haplocrinus granulatus SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 376 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, III, 1886, p. 159 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 252 (catalogue name).

The original description is as follows:

It differs from the *H. hemisphericus* [*Pisocrinus milligani* Miller and Gurley] in being less angular and having a granulated surface.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

HAPLOCRINUS MAXIMUS Troost.

Plate 4, figs. 6, 7, 8.

Haplocrinites maximus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Haplocrinus maximus SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 376 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, III, 1886, p. 159 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 252 (catalogue name).

The original description is as follows:

It is inverted conical, deeply truncated. Superior rim much extended, and the lower rim more prominent. The place for the insertion of the column is much larger than in the other species.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Family SYMBATHOCRINIDÆ Wachsmuth and Springer.

Genus SYMBATHOCRINUS Phillips.

SYMBATHOCRINUS TENNESSEENSIS Roemer.

Symbathocrinites tennesseæ TROOST (in part), Proc. Amer. Ass. Adv. Sci., II, No. 2 (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Symbathocrinus tennesseensis ROEMER, Die Sil. Fauna d. westl. Tenn., 1860, p. 55, pl. IV, fig. 6*a*, *b*.—SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 397 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 285 (catalogue name).

Symbathocrinus tennesseæ WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, III, 1886, p. 166 (catalogue name), p. 174.

Under the name of *Symbathocrinites tennesseeæ*, Troost described two widely different forms. One of these is apparently identical with *S. tennesseensis* Roemer, and the other is described as a separate species, *S. troosti*.

Formation and locality.—Brownsport limestone. Troost records this species as from the Siluric of Decatur County and the Carbonic of White's Creek Springs, but the latter is probably an error as, among the Crinoidea, the same species would hardly be likely to persist from Siluric to Carbonic time, and, moreover, the mode of preservation of the specimens more nearly resembles that of material from Decatur County than from White's Creek Springs.

Cat. No. 39939, U.S.N.M.

SYMBATHOCRINUS TROOSTI, new species.

Plate 9, fig. 9.

Synbathocrinites tennesseeæ TROOST (in part), Proc. Amer. Ass. Adv. Sci., II, No. 2 (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

The figures and the main portion of Troost's description of *Symbathocrinus tennesseeæ* are from the specimens now labeled *S. troosti*, therefore all of the description except a portion referring to the young of *S. tennesseeæ* is reproduced below.

The original description is as follows:

Pelvis [base] circular, divided into three parts (visible in young specimens) with five, rounded [slightly curved] excavations in which are placed: scapulars [radials] five, more or less wedge shaped, tumid, giving a pentagonal form to the cup.

Column cylindrical, radiating [crenulated] around the margin of the articulating surface, and circular alimentary canal [lumen].

Supplementary description.—Basals three, radials five, arm plates not preserved. The angle of divergence between the base and sides of the calyx is about 127°, producing a low, spreading cup. Surface apparently smooth. The species is characterized by the distinctly flattened central portion of the radials and the broad, shallow bevelling of these plates on either side of the sutures.

Observations.—The species is distinguished from *Symbathocrinus tennesseensis* by its greater size, flattened radials, and sunken sutures; and from *S. robustus* by the form of the radials and the low, spreading calyx.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39980, U.S.N.M.

SYMBATHOCRINUS GRANULATUS Troost.

Plate 9, figs. 4, 7, 8.

Synbathocrinites granulatus TROOST, Proc. Amer. Ass. Adv. Sci., II, 1850, p. 61 (*nomen nudum*); MSS., 1850.

Synbathocrinus granulatus SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 397 (catalogue name).

Symbathocrinus granulatus WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, III, 2d sec., 1886, p. 166 (catalogue name).

The original description is as follows:

It differs from *S. tennesseeæ* in having its costals [radials] more elevated, and more convex longitudinally, which elevations terminate in a bevel at the rim of the cup, and in having a granulated surface.

Observations.—The species is characterized by its small size, tuberculate surface, and the form of the radials. The central portions of the latter are strongly convex, bevelled above, producing semicircular flat or concave surfaces between the center and the upper margin of the radials. It closely resembles *Symbathocrinus angularis*

Miller and Gurley [1894], and one of the specimens is flattened laterally, thus increasing the resemblance to that species, but the flattening of the Troost specimen is evidently accidental, as the plates are more or less broken, while the type of *S. angularis* is oval in transverse section.

The species differs from *S. granuliferous* Wetherby [1880] in the form of the radials.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39938, U.S.N.M.

SYMBATHOCRINUS ROBUSTUS Shumard.

Plate 4, fig. 11.

Donacicrinites simplex Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850.

Synbathocrinus robustus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 397.—Meek and Worthen, Geol. Rep. Illinois, VI, 1885, p. 514, pl. xxix, fig. 4.

Symbathocrinus robustus Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 169.—Miller, North Amer. Geol. and Pal., 1889, p. 285 (catalogue name).—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 618 (catalogue name).

The original description by Troost is as follows:

This certainly is the most uncomplicated crinoid that has been discovered. As the specimen is mutilated I can not give a complete description of it.

Its pelvis [base] is almost entirely wanting, only part of a plate exists which shows that the superior margin of it is slightly elevated in the middle upon which succeed five trapezoidal plates having their superior edge large and must be considered as costals [radials]—immediately upon them follows a row of similar plates, having their inferior margin large, which are the scapulars [primibrachs] and support five undivided arms composed of broad plates. The plates are all thick consequently the visceral cavity very small.

Observations.—The specimen described by Troost as a new genus and species with the name of *Donacicrinites simplex* appears to be identical with *Symbathocrinus robustus* Shumard. All the sutures are represented in the figure as more depressed than appears on the specimen, and the artist has figured two more plates on each arm than are actually preserved, but the figure is otherwise a fair representation of the specimen.

Formation and locality.—Keokuk horizon of Tullahoma formation. The specimen is recorded in the manuscript as from Decatur County, but it is preserved in the same way as material from White's Creek Springs, and is probably of the horizon represented at that locality. The locality label of this specimen may have been confused with that of *Symbathocrinus troosti* (*S. tennesseeæ* in part) which was labelled as from White's Creek Springs, while it probably came from Decatur County.

Symbathocrinus robustus is also recorded as from Sulphur Springs, near Nashville, Tennessee; Button-mould Knob, Kentucky; and Greene County, Illinois.

Cat. No. 39940, U.S.N.M.

Order ADUNATA Bather.

GROUP A.

Family PLATYCRINIDÆ Roemer.

Subfamily COCCOCRININÆ Bather.

Genus COCCOCRINUS Müller.

COCCOCRINUS BACCA Roemer.

Plate 4, fig. 9.

Platycrinites Ann Dixoni Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*).

Coccocrinus bacca Roemer, Die Sil. Fauna d. westl. Tenn., 1860, p. 51, pl. IV, figs. 5*a*, *b*, *c*.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 359 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 60 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 232, text fig. 265 (catalogue name).

The description by Troost is as follows:

It has a hemispherical form—a cup shaped pelvis [base] with an extremely small impression for the column. Scapulars [radials] large.—Arms much projecting, which gives a pentagonal appearance to the superior rim. Interscapulars [interbrachials] much elevated. Surface smooth.

Observations.—Two well preserved specimens of the dorsal cup of this species were described by Troost as new species of the genus *Platycrinus*. They show the second primibrachs in one or more of the rays, and otherwise agree with the figures and description of Roemer's species.

Formation and locality.—This species is characteristic of the lower, or Coccocrinus zone, of the Beech River formation of the Brownsport limestone, as defined by Pate and Bassler [1908]. Decatur County, Tennessee.

Cat. No. 39888, U.S.N.M.

COCCOCRINUS CONICUS (Troost).

Plate 15, fig. 1.

Cupellæcrinites conicus Troost, MSS., 1850.

This species was referred by Troost to his genus *Cupellæcrinites*, which is a synonym for *Marsipocrinus* Bather. His description of the species is as follows:

It is inverted conical and differs much from the general form of the species of this genus [*Marsipocrinus*]. The pentagonal pelvis [base] forms a deep cup; the hexagonal costals [radials] are elongated—scapulars and interscapulars [first brachials and interbrachials] similar to those of the other species [of *Marsipocrinus*].

Supplementary description.—Basals three, unequal; radials five, slightly longer than wide; first primibrachs quadrangular, about twice as wide as long; second primibrachs represented by fragments only, but apparently shorter than the first; first interbrachials half as large as the radials, nine sided; higher plates of the calyx not preserved.

Observations.—This species differs from *Coccocrinus bacca* in its larger size and in having the sides of the calyx more divergent and less curved.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39933, U.S.N.M.

Subfamily MARSIPOCRININÆ Bather.

Genus MARSIPOCRINUS Bather.

Marsupiocrinus Phillips (not de Blainville 1830), in Murchison's Sil. System, 1839, p. 672.—Austin, Ann. Mag. Nat. Hist., X, 1842, p. 109; 1843, p. 198.—Pictet, Traité de Pal., IV, 1857, p. 332.—Dujardin and Hupé, Hist. Nat. Zooph., 1866, p. 149.—Angelin, Icon. Crin. Suec., 1878, p. 2.—Zittel, Handb. d. Pal., 1879, p. 365.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 62.—Miller, North Amer. Geol. and Pal., 1889, p. 260.—Zittel, Text Book of Pal. (Eastman trans.), 1896, p. 139.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 730.

Cupellæcrinites Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61.

Cupellæcrinus Shumard (not Steininger), Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 380.

Marsipocrinus Bather, Quart. Journ. Geol. Soc. London, XLV, 1889, p. 173; A Treatise on Zool., III, Echinoderma, 1900, p. 156.

The description by Troost is as follows:

Pelvis [base]—pentagonal formed mostly of three pieces.

Costals [radials] five, compressed hexagonal. Scapulars [primibrachs] five, of various forms.

Column—Cylindrical with circular or pentalobate alimentary canal [lumen].

MARSIPOCRINUS TENNESSEENSIS (Roemer).

Plate 9, figs. 5, 6.

Cupellæcrinites buchii Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Cupellæcrinites laevis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Platycrinus tennesseensis Roemer, Sil. Fauna westl. Tenn., 1860, p. 35, pl. III, figs. 4*a–e*.

Cupellæcrinus tennesseensis Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 362 (catalogue name).

Cupellæcrinus lævis Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 361 (catalogue name).

Marsupiocrinus tennesseensis Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 65 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 260.

The description of *Cupellæcrinites lævis* by Troost is as follows:

Pelvis [base] almost flat, more or less depressed towards the center; a circular alimentary perforation [lumen], surrounded with an elevated border. No division perceptible not even in the young specimens.

Costals [radials] five, hexagonal, longitudinally depressed, resting with one of the broad sides upon the large pelvis and forming with the pelvis the flat bottom of the cup.

Scapulars [secundibrachs] five [ten] quadrilateral—having an excavation of a semicircular form in the center of the superior margin [of the two plates] for the reception of the arms—This superior margin forms part of the border of the cup. Inter-scapulars [interbrachials] five, pentagonal, an angle of which fills the re-entering angle formed by the junction of two hexagonal costals [radials]—the superior margin completing the border of the cup.

Arms—five, dividing into two hands (such is the case with all the other species—in this that part is mutilated).

Column cylindrical with circular alimentary canal [lumen].

Capital integument unknown.

It is remarkably flat, its diameter being 40 mill. m. while its height is only 13 mill. m.

The surface is smooth.

The description of *Cupellæcrinites buchii* by Troost is as follows:

It differs from *C. laevis* in the construction of the scapulars [secundibrachs] which at the superior margin receive several small plates projecting much above the general level in the centre of the body; on both sides of this projection is a horse shoe excavation for two hands? Consequently the division of the arms takes place immediately at the body which is not the case with the *C. laevis*. It is also more elevated, the costals [radials] being in proportion longer and more raised towards the border of the cup, and slightly concave towards the centre.

Observations.—Troost described under the name of *Cupellæcrinites buchii* a large *Marsipocrinus* which is apparently of the same species as *Marsipocrinus tennesseensis* (Roemer). Nearly all of the outer surface of the specimens has been removed and several of them are quite smooth, while others show traces of fine radiating ridges.

Cupellæcrinites buchii Troost was separated from *C. lævis* Troost on account of a supposed difference in the branching of the arms. In *C. lævis* the plates of the calyx are not preserved above the first secundibrachs, and the large hemispherical opening thus produced was supposed to be the opening for a single arm which branched later. *C. buchii* is said to be a more elevated form but this appearance is also produced by the greater number of plates preserved in its calyx. So far as preserved the plates of *C. lævis* correspond with those of *C. buchii*, and it is therefore referred with the latter to *Marsipocrinus tennesseensis* (Roemer).

Formation and locality.—Brownsport limestone, Eucalyptocrinus zone of the Beech River formation. Decatur County, Tennessee. The following species are mentioned by Troost as occurring in association with *Marsipocrinus tennesseensis:*

Calceola tennesseeæ, Terebratula [*Whitfieldella*] *oblata, Leptaena* [*Spirifer*] *imbrex, Leptaena depressa* [*rhomboidalis*], *Pentremites* [*Troostocrinus*] *reinwardtii, Calymene blumenbachi* var. *niagarensis.*

Cat. Nos. 39925, 39928, U.S.N.M.

MARSIPOCRINUS VERNEUILI (Troost).

Plate 9, figs. 10, 11, 12.

Cupellæcrinites verneuilii TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61; Mss., 1850.

The original description is as follows:

This little *Cupellæcrinites* [*Marsipocrinus*] approaches in its general form the *C. lævis* [*C. tennesseeæ*].

Pelvis [base]—pentagonal.—The impression for the column pentagonal [circular], very large and surrounded with an elevated margin; the angles of this elevated border not opposed to the angles of the pelvis [base] but intermediate; alimentary [axial] canal pentagonal. The whole of the lower surface corrugate. The division of the scapulars [secundibrachs] very plain.

This species is ornamented by series of tubercles [ridges] numerous, irregular; 1st upon the hexagonal costal [radial] rests a small cuneiform plate which supports two larger plates which cover at the same time one-half of the superior margin of the costal [radial], upon this plate (the one that is supported by the above-mentioned cuneiform plate), rests another cuneiform plate which projects considerably beyond the general circumference of the body and supports partly the plate in which the horse shoe excavation for the hand [arm] is situated.—This is repeated on the other inclined plain of the said cuneiform plate. As all these plates are tumous and corrugate the joints are easily observed—in fact, though small, it exhibits its characters better than any other species; but it is particularly its plated coronal integument which is admirable and which seems to have been formed from a complicated design copied from those exhibited by the kaleidoscope. It is a kind of mosaic composed of three stars, the one surrounding the others.—The smallest, or central one, is composed simply of five rhombs [orals]—between the reentering angles of which, are placed five subpentagonal plates [interambulacrals] so as to project far beyond the rhombs of the first star—this forms the second star which projects for about half the radius of the whole circular integument except on one of its angles where we have the oral [anal] aperture (only discovered on this and on the *C. magnificus*). This star is followed by the third which is more complicated. We have first five pair of double points [interambulacrals],—two elongated polygonal plates joined side by side—they are separated on each side by two rows of small tubercles [ambulacral plates] which proceed from the central star to—and penetrate the aperture of the hands [arms] after being divided as seen in the figure; secondly we have five single points [plates] projecting a little beyond the double points [of the interambulacrals], from which they are separated by two rows of double series of tubercles [ambulacral plates] as mentioned above.

Observations.—The elevated rim around the column is a well-marked feature of the species. It has an irregular outline, suggesting a pentagonal or triangular form. The surface is beautifully ornamented with delicate, irregularly branching ridges which on the radials appear to start at the center of the upper margin, radiating outward and downward, and on other plates to pass transversely across them.

Troost's description and figures of the tegmen represent it as nearly radially symmetrical, taking too little account of the irregularity produced by the anal area. The five oral plates are tumid and easily distinguished. They are grouped on the anterior half of the tegmen, as shown by fig. 12, plate 9. The anal aperture is surrounded by several rows of minute plates which merge into those of

the posterior ambulacra and interambulacrum. The interambulacrals are the largest plates of the tegmen. There are four or five of the large plates, ornamented by tubercles, and several smaller accessory pieces. Troost's description applies to the right antero and postero-lateral interambulacral areas, but the others are less regular. The ambulacral areas are covered by two rows of small convex plates. About halfway from the center to the margin each area divides, giving rise to two branches with a double series of minute covering pieces. Each of these again divides, its inner branch going to an arm base and the outer terminating on the upper surface of a small second interbrachial. Near the margin still another branch passes to the upper surface of the second secundibrach.

This species is distinguished from *Marsipocrinus tennesseensis* by its small size, the character of the tegmen plates, and the surface ornament.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39924, U.S.N.M.

MARSIPOCRINUS STRIATUS (Wachsmuth and Springer).

Plate 9, figs. 13, 14.

Cupellæcrinites striatus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Cupellæcrinites inflatus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61; MSS., 1850.

Cupellæcrinus striatus SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 362 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 230 (catalogue name).

Cupellæcrinus inflatus WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 230 (catalogue name).

Marsupiocrinus striatus WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, 1897, p. 732, pl. LXXV, figs. 17, 18.

The name *striatus* was first proposed by Troost for a species of *Marsipocrinus* in 1850.

His description is as follows:

I found only one partly complete specimen of this species. Detached pelvic [basal] plates are rather abundant, they are generally large, some as much as 30 mill. m. in diameter, divisible into three parts, not depressed towards the centre as in the *C. lævis* [*Marsipocrinus tennessensis*] but rather convex. The alimentary aperture [lumen] is pentalobed and is surrounded with an elevated circular border. They are striated,—the stria running at right angles from the margin of the plate.

Some, perhaps the same species, have five rays running from the centre towards the circumference.

Observations.—The basal plates here described differ from those of *Marsipocrinus striatus* Wachsmuth and Springer in being convex instead of concave, and they may belong to a different species, but in the absence of the specimens it is impossible to determine this with

certainty. The nearly complete calyx labeled in Troost's handwriting *Cupellæcrinites striatus* is of the same species as *Marsipocrinus striatus* Wachsmuth and Springer. In connection with their description these authors do not refer to the previous use of the name *striatus* by Troost, and were, perhaps, unaware of the identity of his species with theirs. The *Cupellæcrinites striatus* Troost differs from that of Wachsmuth and Springer in having the angle of the basi-radial sutures only faintly indicated or absent, but this is a variable feature, as shown by a specimen in which one of the sutures is sharply angled and another straight.

Cupellæcrinites inflatus Troost is said to differ from *C. striatus* in having a more elevated calyx, but this appearance of greater height is produced by the preservation on the former of a portion of the tegmen. The height of both is about the same to the top of the first interbrachials, and they are included in one species.

Marsipocrinus striatus differs from *M. tennesseensis* Roemer in the finer surface striæ, the strongly beveled sutures and the depressed base.

Formation and locality.—Brownsport limestone, Eucalyptocrinus zone of the Beech River formation. Decatur County, Tennessee.

Cat. Nos. 39926, 39934, U.S.N.M.

MARSIPOCRINUS MAGNIFICUS (Troost).

Plate 10, figs. 5, 6, 7.

Cuppellæcrinites magnificus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*).

Cupellæcrinus magnificus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 361 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 230 (catalogue name).

The original description is as follows:

The perfect preservation of the specimen from which this description is drawn up (it being siliceous, and without blemish), the beautiful insculpted surface, and the regular dome-shaped mammillary capital cover [tegmen] surrounded with five rostra or beak-like projections which adorn the angles, giving it a pentagonal form, caused me to adopt for this species, the name of *magnificus*.

Pelvis [base]—pentagonal with curvilinear margins—a pentalobed alimentary aperture [lumen], in the center, surrounded with a corrugate elevated circle—the impression of the column shows that it was cylindrical—the elevated circle is enclosed in a broad corrugate border reaching to the edge of the pelvis. From each of the angles of the pentagonal pelvis proceeds a row of tubercles which meet together on the costals [radials] at a line of similar tubercules running from two opposite angles of the hexagon, parallel with the sides by which the inferior half of the costals [radials] is divided into three equilateral triangles, so that the pelvis [base] is surrounded by 15 equilateral triangles—the interior space of these triangles is irregularly tuberculated, such is also the case with the superior half of the hexagonal costals [radials] which form part of the elevated sides of the cup, while most of the lower half forms with the pelvis [base] the bottom of it.

The scapulars [secundibrachs], which rest upon the superior margin of the hexagonal costals [radials] exhibit at the lower part a kind of rosette [the small primibrach],

projecting above the general level of the body, above it is another complicated projection, having somewhat the appearance of that given by artists of the Roman rostra, which divides the hands [arms] which in this specimen are from 3 to 4—I think the number must have been four in the living animal. The connecting points of these plates are entirely obliterated by the complicated carving.

The interscapulars [interbrachials] are also gracefully ornamented—the lower part resembles a coat of arms, the upper part, more projecting, resembles the heraldic ornament which completes the armour.

The capital integument is composed of polygonal plates being externally globular, and nothing gives a better idea of the term mammillary, because most of these hemispherical elevations are surmounted by a papilla.

The only well defined [anal] aperture that I have seen in the Cupellæcrinites is in this species—it is sub-central and is partly closed by two small tubes geniculately connected—whether this is accidentally a post mortem introduction, I can not say, probably the latter.

Observations.—This beautiful species of *Marsipocrinus* is distinguished from all others of the genus by the elaborate surface ornament, the heavy, nodose plates of the tegmen and the four arms to the ray.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39927, U.S.N.M.

MARSIPOCRINUS CORRUGATUS (Troost).

Plate 10, fig. 8.

Cupellæcrinites corrugatus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Cupellæcrinus corrugatus SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, p. 361 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 230 (catalogue name).

The original description is as follows:

In its general form it resembles the *C. lævis* [*C. tennesseensis*] but it differs from it in having a pentalobate [?] alimentary aperture [lumen],—the pelvis [base] is not depressed towards the center but rather convex, the costals [radials] are less elevated which give a larger surface to the bottom, and the whole surface is irregularly wrinkled, which wrinkles increase in height towards the lines radiating from the cicatrice left by the column, towards the five angles of the pelvis [base]. The costals [radials] in my specimen are mutilated and the coronal integument entirely destroyed.

Supplementary description.—Calyx very flat, and consisting of basals, radials, and primibrachs only. The basals extend horizontally and have, at the center, a slightly elevated circular disc to which the column is attached. The radials are large, and they form only a slight angle with the basals. Primibrachs very small. All plates of the calyx strongly beveled at the sutures. The entire surface is closely set with very irregular, rounded ridges.

Observations.—This species differs from *Marsipocrinus verneuili*, its nearest ally, in the beveled sutures and in the surface ridges which are coarser, more numerous, and more irregular. The primibrachs

are also much smaller in proportion to the size of the radials, and the elevation for the attachment of the column differs in being distinctly circular in outline and uniform in thickness. Contrary to Troost's observation, the lumen, in the only specimen which shows this feature, is plainly circular.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39930, U.S.N.M.

MARSIPOCRINUS STELLATUS (Troost).

Plate 10, figs. 1, 2.

Cupellæcrinites stellatus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Cupellæcrinus stellatus SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 361 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea II, 1881, p. 230 (catalogue name).

The original description is as follows.

A pentagonal flat disk, slightly depressed towards the center. The costals [radials] lie in the same plane with the pelvis [base] only slightly elevated, so that the scapulars [secundibrachs] and inter-costals [interbrachials] alone form the sides of the cup. The arms and hands [arm bases] project considerably beyond the general circumference which gives it the form of a star with five rays. The circular elevated ridge round the cicatrice of the column, is surrounded with a pentagonal elevated border.—Surface smooth,—coronal integument [tegmen] slightly elevated towards the center, composed of smooth polygonal plates; oral [anal] aperture subcentral. The rows of tubercles, mentioned in the description of *C. verneuili*, are visible in this species, where they join the hands [arms].

Observations.—The calyx is hardly so flat as indicated by Troost's description, for the radials are bent upward and take part, at least in their upper portion, in the formation of the dorsal cup. The arm bases are protruding and deflected slightly downward from the horizontal. Some portions of the surface show trace of radiating ridges, but the ornament has been nearly all removed by solution or silicification. On the tegmen the ambulacral plates are larger and less easily distinguished from the interambulacrals than is the case with *Marsipocrinus verneuili*. The plates of the tegmen are nearly flat with the exception of a few of the ambulacrals which are slightly nodose.

This species is nearest to *Marsipocrinus tennesseensis*, but differs in the presence of a distinct rim around the area for the attachment of the column, the more prominent deflected arms, and the smooth instead of nodose tegmen plates.

Formation and locality.—Brownsport limestone. Perry or Decatur County, Tennessee.

Cat. No. 39929, U.S.N.M.

MARSIPOCRINUS ROSÆFORMIS (Troost).

Plate 13, figs. 5, 6.

Cupellæcrinites rosæformis TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Cupellæcrinus rosaformis SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 361 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 230 (catalogue name).

The original description is as follows:

A circular disk more or less angular produced by the lateral projections of the inter scapulars [interbrachials] Pelvis [base], costals [radials], scapulars [primibrachs] and arms lie in the same plane—the interscapulars [interbrachials] only more or less elevated, so that the hands [arms] seem to have immediately descended [extended laterally]. Lower surface smooth [?]—alimentary aperture [lumen] pentalobate, coronal integument [tegmen] hemispherical, composed of tumid polygonal plates. Oral [anal] aperture subcentral.

In this species the rows of tubercles [tumid ambulacral plates] so conspicuous in the *C. verneuili* make their appearance near the circumference where they are divided into four rows and seem to penetrate or join the hands [arms]. This is another beautiful species of this genus.

Observations.—The surface ornament consists of fine irregular ridges radiating from the center of the upper margin of the radials and from the transverse ridge across the interbrachials. The sutures are sunken in narrow but deep grooves. The interbrachials are flat below and convex above; the tegminal portion bends upward at a sharp angle from the flat surface which forms a part of the calyx.

This species is distinguished from others of the genus by the extremely flat calyx and the protruding interbrachials. The latter give the calyx a ten-sided outline, forming five angles between those of the arm bases.

The specimens figured by Wachsmuth and Springer [1897, pl. 75, figs. 16*a*, *b*], and identified with *Marsipocrinus tennesseensis* Roemer resembles *M. rosæformis* in form and surface ornament, but the sutures are described as not sunken and difficult to distinguish. Notwithstanding this difference the figures seem to indicate a specimen more nearly related to *M. rosæformis* than to *M. tennesseensis*.

Formation and locality.—Brownsport limestone. Perry County, Tennessee.

Cat. No. 39932, U.S.N.M.

MARSIPOCRINUS PENTAGONALIS (Troost).

Cupellæcrinites pentagonalis TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*).

Cupellæcrinus pentagonalis SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 361 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 230 (catalogue name).

The original description is as follows:

Resembles the *C.* [*Marsipocrinus*] *rosæformis* but the interscapulars, [interbrachials] being elevated and consequently the arms more projecting, give it a pentagonal form. The costals [radials] are also more elevated which give the whole a saucer shape appearance. The coronal integument [tegmen] is similar to but less elevated than the *C. rosæformis.*

Observations.—This species is most nearly related to *Marsipocrinus rosæformis,* but differs in its deeper calyx, pentagonal outline, and stronger and more regular surface ridges. The interbrachials in this form are nearly vertical instead of laterally extended as in *M. rosæformis.* A faint groove marks the position of the sutures. *M. pentagonalis* is distinguished from *M. stellatus* by the deeper calyx and stronger surface ornament, and the plates of the tegmen are also more convex.

Formation and locality.—Brownsport limestone. Perry County, Tennessee.

Cat. No. 39931, U.S.N.M.

Subfamily PLATYCRININÆ Bather.

Genus PLATYCRINUS Miller.

PLATYCRINUS HUNTSVILLÆ (Troost) Wachsmuth and Springer.

Plate 5, figs. 10, 11, 12.

Platycrinites huntsvillæ Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Platycrinites polydactilus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*).

Platycrinus penicillus Meek and Worthen, Proc. Acad. Nat. Sci. Phila., 1860, p. 380; Geol. Surv. Illinois, II, 1866, p. 266, pl. xix, figs. 6*a–c*.

Platycrinus plenus Meek and Worthen, Proc. Acad. Nat. Sci. Phila., 1860, p. 380; Geol. Surv. Illinois, III, 1866, p. 267, pl. xx, fig. 3.

Platycrinus huntsvillæ Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 388 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 234 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 271 (catalogue name).—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 678, pl. lxxiii, figs. 6, 7*a*, 7*b*, 8, 9, 10, 11, 12.—Weller, Bull. No. 153, U. S. Geol. Surv. 1898, p. 441 (catalogue name).

Platycrinus polydactylus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 389 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea II, 1881, p. 235 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 271 (catalogue name).

Platycrinus alabamensis Miller, 17th Rep. Geol. Surv. Indiana, 1892, p. 660, pl. ix, fig. 5.

The following is the description of *Platycrinus huntsvillæ* by Troost:

This species resembles more or less to the *Platycrinites lævis* of Miller, but its pelvis [base] differs from that of *P. lævis.* The aperture for the insertion of the column is surrounded with an elevated circle, from which proceed three elevated ridges. It possesses also a small interscapular [interbrachial] of an irregular form. Its column is cylindrical not elliptical as the *P. lævis.*

It occurs in the Carboniferous limestone in the vicinity of Huntsville and in the oolitic limestone of the Cumberland Mountains, Tennessee—in the latter locality I found only fragments.

The following is the description of *Platycrinus polydactylus* by Troost:

It is distinguished from *P. huntsvillæ* in the division of the hands [arms]—in this species one of the hands [arms] is subdivided into two as in the *P. huntsvillæ*, while the other is subdivided into three so that we have alternately 2 and 3 or 25 fingers [ramuli] in all while in the *P. huntsvillæ* we have only 20—besides the body is more elongated.

Observations.—The first published description of this species is by Wachsmuth and Springer [1897], although the name was proposed by Troost in 1850. Troost separated *Platycrinus polydactylus* from *P. huntsvillæ* on account of the more freely branching arms of the former, but Wachsmuth and Springer state that in a large number of individuals the branching of the arms is too variable to be used for the separation of species.

Formation and locality.—St. Louis group. Huntsville, Alabama; Hardin County, Illinois.

Cat. Nos. 39886, 39887, U.S.N.M.

PLATYCRINUS SAFFORDI Hall.

Plate 15, fig. 10.

Platycrinus saffordi Troost, MSS., 1850.—Hall, Geol. Rep. Iowa, I, Pt. 2, 1858, p. 634, pl. xviii, figs. 5, 6.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 389 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 74 (catalogue name).—Miller, North Amer. Geol. and Pal., 1899, p. 271 (catalogue name).—Keyes, Missouri Geol. Surv., IV, 1894, p. 212, pl. xxv, fig. 1.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 694, pl. lxvii, figs. 1–3.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 445 (catalogue name).

Troost says of this species:

This large crinoid has excited in me no less admiration than I experienced when I examined for the first time the splendid *Actinocrinites humboldti* [*Actinocrinus magnificus* Wachsmuth and Springer.] It is equally large and beautifully ornamented, but equally delicate and fragile. Only mutilated specimens are now discovered of it. One of these, nevertheless, in my collection shows enough of its generic characters to rank it amongst the genus *Platycrinites*. I possess of it a complete pelvis [base] and another which contains yet two perfect plates of the scapulars [radials].

The pelvis [base] has the form of a large basin considerably extending beyond the lower part of it [i. e. the surface for attachment of the column] the superior rim being cut out with five concave spaces, into which are placed five somewhat irregular, quadrilateral scapulars [radials]. These scapulars [radials] have no [an] excavation in the center of the superior margin as is the case in the scapulars [radials] of the *Platycrinites*, but have a horseshoe-like, small plate (arm plate) which inclines backwards forming almost a right angle with the surface of the plates, and is externally ornamented with some projecting tubercles to which [i. e. to this plate] seems to have attached the arms.

On none of the two pelves [bases] that I possess are any traces of junction of the plates visible, which junctions, even if they existed, would have been obliterated by

the ridges, mostly horizontal but a few transverse, with which the surface of the plates is ornamented.

One of the columnar joints which is circular and large, is yet attached to the cavity, but the alimentary canal [lumen] is completely filled with siliceous matter and consequently obliterated.

The ornamental ridges on the scapulars [radials] are very regular and exactly represented in the figure.

It was discovered by Prof. J. M. Safford * * * to whom I have dedicated the species.

Observations.—As will be seen by a comparison of the figures, the specimen substituted by Hall for the type of this species is less than half the size of Troost's type, and it differs in the character of the surface ornament. On Troost's type many of the nodes become confluent, producing ridges parallel to the margins of the plates, so that while lines of nodes are present running from the angles of the plates, parallel ridges form a more characteristic feature of the ornament. Hall's specimen is probably a young individual of the species.

Formation and locality.—Upper Burlington and Keokuk group. Scottsville, Kentucky. Reported also from Indian Creek, Montgomery County, Indiana; Keokuk, Iowa; Tennessee, Illinois, and Missouri.

Cat. No. 39890, U.S.N.M.

PLATYCRINUS INSCULPTUS Troost.

Plate 4, fig. 18.

Platycrinites insculptus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850.

Platycrinus insculptus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 388 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 234 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 271 (catalogue name).

The description by Troost is as follows:

Of this species I possess only a pelvis [base]. It is distinguished from the preceding species which are smooth by its engraved surface. The elevated circle around the alimentary aperture [lumen] is also broader, has a more or less triangular form and from each of the angles projects a little ridge. The remainder of the pelvis is adorned first by a row of tubercles running along the margin, then five rows running from each of the angles of the pentagonal pelvis to the circle around the alimentary aperture [lumen].

Cumberland Mountains, Tennessee and Alabama.

Observations.—This species is described from the basal plates only and it is quite possible that it belongs to some already described species, but as the specimen is missing, it is impossible from the figure alone to place it with any degree of certainty. Since the name has already appeared in the literature it seems best to publish such evidence as exists concerning it, and await the collection of more complete material from the same localities.

Family HEXACRINIDÆ Wachsmuth and Springer.

Genus TALAROCRINUS Wachsmuth and Springer.

Dæmonocrinites Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*), MSS., 1850.

Doliolocrinites Troost, MSS., 1850.

Dichocrinus Shumard (in part), (not Münster) Trans. Acad. Sci. St. Louis, I, 1857, p. 71.—Casseday and Lyon (in part), Proc. Amer. Acad. Arts and Sci., V, 1862, p. 16.

Talarocrinus Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 85.—Miller, North Amer. Geol. and Pal., 1889, p. 285.—Zittel, Text Book of Pal. (Eastman trans.), 1896, p. 140.—Bather, A Treatise on Zool., III, The Echinoderma, 1900, p. 159.

The following is a description of *Dæmonocrinites* by Troost:

Generic characters—Pelvis [base] divided into two parts.

I found it rather difficult to select a name for this heterodox crinoid—I could not compare it with any natural object, and having two horns I could not dedicate it to any of my scientific friends—so I have put it under the patronage of one who is generally represented with such ornaments.

The following description of *Doliolocrinites* is by Troost:

Generic characters—Pelvis [base] hemispherical composed of six [two] subpentagonal plates supporting six subpentagonal scapulars [radials and anal plate].

TALAROCRINUS SYMMETRICUS (Lyon and Casseday).

Plate 4, figs. 1, 2.

Dæmonocrinites cornutus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850.

Dichocrinus symmetricus Lyon and Casseday, Proc. Amer. Acad. Arts and Sci., Boston, V, 1862, p. 20.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 367 (catalogue name).

Dichocrinus elegans Lyon and Casseday, Proc. Amer. Acad. Arts and Sci., Boston, V, 1862, p. 22.

Talarocrinus symmetricus Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 87 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 285 (catalogue name).—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 786, pl. lxxviii, figs. 4*a*, *b*, and 5.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 624 (catalogue name).

Talarocrinus elegans Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 87 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 285 (catalogue name).

The following description is by Troost:

Pelvis [base] irregular, more or less hexagonal, divided into two parts.

Costals [radials and anal plate], six, subhexagonal, almost spherical, forming, connected, an irregular hexagon with rounded angles.

Column cylindrical with a circular alimentary canal [lumen].

Capital integument [tegmen]—in the form of a hemispherical dome having two horn-shaped projections at the sides and a small, pointed protuberance at the summit.

At the base of this capital integument are 5 or 6 apertures divided longitudinally by a septum, probably the apertures for the arms—above one of these apertures, near the summit is another aperture, probably the mouth [anus].

Observations.—Doctor Troost's specimen of this species is missing, but his figure is sufficiently good to show that it should be referred to *Talarocrinus symmetricus* Lyon and Casseday.

Formation and locality.—Bangor limestone. Near Craborchard, Cumberland Mountains, Tennessee. Doctor Troost reports fragments of the species from the Silurian of Decatur County, but these are probably incorrectly identified. Also from the upper part of the St. Louis limestone. Grayson, Edmondson, and Pulaski counties, Kentucky.

TALAROCRINUS SIMPLEX (Shumard).

Plate 13, fig. 1.

Doliolocrinites ovalis TROOST, MSS., 1850.

Dichocrinus simplex SHUMARD, Trans. Acad. Sci. St. Louis, I, 1857, p. 74, pl. I, figs. 2*a*, *b*.—HALL, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 654, pl. XXII, figs. 12*a*, *b*; Suppl. Rep. Geol. Surv. Iowa, 1860, pl. I, figs. 4*a*–*c*.—SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 366 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p 84 (catalogue name).

Talarocrinus simplex KEYES, Missouri Geol. Surv., IV, 1894, p. 205, pl. XXV, fig. 6.—WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, 1897, p. 790, pl. LXXVIII, figs. 8*a*, *b*.—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 624 (catalogue name).

The original description by Troost is as follows:

This crinoid is one of the most simple that I have met with. It is formed of twelve more or less elongated, pentagonal or arrow-head shaped plates—six [two] of which (the short ones) forming the pelvis [base] having the point downwards; this point is truncated having a circular cavity in which is fixed a cylindrical column; the superior margins on both sides bevelled and receive between them six larger scapular plates, [five radials and the anal plate] filling the reentering angles of the pelvic [basal] plates. These six scapular plates are more deeply truncated at the acute angle forming, when joined together, the rim of the visceral cavity which has interiorly six semilunar excavations for six [five] arms.

Observations.—Doctor Troost's specimen of *Doliolocrinites ovalis* is apparently a *Talarocrinus simplex* (Shumard). Safford [1869, p. 346] and Hall [1858, p. 655], both of whom probably saw the original specimen, have referred it to this species. The statement that there are six basals is undoubtedly an error. Observing suture lines below two of the radials, Doctor Troost has assumed that they occurred symmetrically all around the base. This assumption of a completely radial symmetry is common in the earlier descriptions of crinoids.

Formation and locality.—Tullahoma formation. Near Gallatin, Tennessee. Also recorded from Spergen Hill, Indiana, St. Genevieve County, Missouri, and from Kentucky.

Cat. No. 39984, U.S.N.M.

Genus PTEROTOCRINUS Lyon and Casseday.

Codonicrinites Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850 (*nomen nudum*); MSS., 1850.

Asteriocrinus Lyon (not Münster, 1839), Geol. Rep. Kentucky, III, 1857, p. 472.

Pterotocrinus Lyon and Casseday, Amer. Jour. Sci. (2), XXIX, 1859, p. 68.—Meek and Worthen, Geol. Rep. Illinois, II, 1866, p. 288.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 394.—Wetherby, Journ. Cincinnati Soc. Nat. Hist., II, 1879, p. 134.—Zittel, Handb. d. Pal., I, 1879, p. 365.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 87; III, 1885, p. 120.—Miller, North Amer. Geol. and Pal., 1889, p. 276.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 791.—Bather, A Treatise on Zool., III, The Echinoderma, 1900, p. 159.

The original description of *Codonicrinites* by Troost is as follows:

Generic characters.

Pelvis [base] hexagonal divided into two equal parts.

Scapulars [radials] five, pentagonal deeply truncated.

Interscapular, one—conical.

Arms, five—divided into four feathered hands which are separated four by four by a solid plate originating upon the superior angle of the arm plates.[a]

Column, cylindrical. Alimentary canal [lumen] circular.

PTEROTOCRINUS ACUTUS Wetherby.

Codonicrinites gracilis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Pterotocrinus acutus Wetherby, Journ. Cincinnati Soc. Nat. Hist., II, 1879, p. 134, pl. XI*e*, figs. 2*a*, *b*, *c*.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 91.—Miller, North Amer. Geol. and Pal., 1889, p. 276.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, II, 1897, p. 799, pl. LXXIX, figs. 3*a–g*.

Pterotocrinus spatulatus Wetherby, Journ. Cincinnati Soc. Nat. Hist., II, 1879, p. 137, pl. III, fig. 3.

Troost's description of this species is as follows:

It has the form of a small bell or obtuse cone, having five broad projections around the rim, from which proceed the arms, or considering the whole, with its superstructure, it resembles the ornaments known by the name of tassels.

The hexagonal pelvis [base] is divided into two equal parts, the dividing line proceeding upwards [downward] from the inferior edge of one of the scapulars [radials], traversing the alimentary canal [lumen], and terminating at the inferior margin of the interscapular [radianal].

Scapulars [radials] five,—irregular pentagonal [hexagonal] deeply truncated on its superior angle, forming a slightly concave excavation, in the middle of which is a small polygonal plate which enters partly the superior edge of the large scapular [radial] and partly the two small plates which are placed in the excavation before mentioned. These small plates are joined together in such a manner as to form a curve, upon which are placed four small flat quadrilateral plates, from each of which proceeds a hand [arm].

From the summit of the above mentioned curve proceeds a solid plate, which terminates at the superior extremity of the hands [arms], and divides them as is the

[a] As long as we have pelvis, ribs, shoulders, arms, hands and fingers in the crinoids, we of course must make use of these names, but it puzzles me often, as in this fossil to distinguish an arm from a hand. As everything will be cleared up by the figures, I hope the arms and hands will be found out.—Troost.

case in the *Eucalyptocrinites;* but in the *Codonicrinites* [*Pterotocrinus*] they are divided into four hands [arms] whereas in the *Eucalyptocrinites* they are divided into two; consequently the first has only five solid plates and 20 hands [arms] and the latter ten solid plates.

It has only one interscapular [interbrachial] of an obtuse conical form and is placed upon the junction of the two pelvic [radial] plates.

I discovered it in the Carboniferous strata in the Cumberland Mountains, Tennessee, and in the same formation near Huntsville, Alabama.

Formation and locality.—Kaskaskia group. Cumberland Mountains, Tennessee; Pulaski County, Kentucky; Huntsville, Alabama. Cat. No. 39922, U.S.N.M.

Order MONOCYCLICA CAMERATA Bather (Wachsmuth and Springer, part.)

Suborder MELOCRINOIDEA Bather.

Family MELOCRINIDÆ Zittel (emend. Wachsmuth and Springer).

Genus MELOCRINUS Goldfuss.

MELOCRINUS ROEMERI Wachsmuth and Springer.

Plate 10, figs. 11, 12.

Actinocrinites verneuili Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849) 1850, p. 60 (*nomen nudum*).

Turbinicrinites verneuili Troost; MSS., 1850.

Cytocrinus lævis Roemer, Die Sil. Fauna d. westl. Tenn., 1860, p. 56, pl. iv, figs. 2*a*, *b*.

Melocrinus verneuili Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 381 (catalogue name).—Hall, 20th Rep. New York State Cab. Nat. Hist., 1867, p. 327, pl. x, fig. 5.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 122 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 261.

Ctenocrinus lævis Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 361 (catalogue name).

Melocrinus lævis Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 122 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 261 (catalogue name).

Melocrinus roemeri Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 301, pl. xxii, figs. 11*a*, *b*.

The reference of this species to *Actinocrinus* is explained by Doctor Troost as follows:

This crinoid (having only mutilated specimens of it) was mistaken for an *Actinocrinites* and mentioned in the list of new crinoids published in the transactions of the Association of Naturalists in Boston, in 1849, under the name of *A. verneuili.* Having since discovered a more perfect specimen I have seen mine error, and that it differs in its generic characters from *Actinocrinites.*

To this new genus I have applied the name of *Turbinicrinites* from *Turbinis*, top, to which I have retained the specific name of *verneuili.*

It is inverted conical; its superior rim is pentagonal, the angles much projecting and terminating in an arm.

The capital integument is elevated in the center and is covered with polygonal small plates terminating in the center in a rosette. The oral [anal] aperture is subcentral.

Observations.—The genus *Turbinicrinites* was founded upon one specimen in a collection of six individuals. In this specimen the lower margin of the first anal plate truncates the upper edge of the posterior basal (plate 10, fig. 6). This structure was produced by the earlier introduction of the anal plate, causing it to occupy a lower position in the calyx than in normal individuals. The specimen is otherwise indistinguishable from undoubted specimens of *Melocrinus roemeri* with which it is associated. This fact and the absence of other specimens showing similar variation has led to the conclusion that the lower position of the anal plate is an abnormal feature characteristic of a single individual only.

A detailed description of the plates of the calyx is given by Roemer [1860, p. 56] in the original description of the species. Having only imperfect specimens Roemer described the basal plates as three in number, an error which was corrected by Wachsmuth and Springer [1881, p. 119].

Formation and locality.—Brownsport limestone. Decatur County, Tennessee. Also recorded by Roemer from Beargrass Creek, Kentucky.

Cat. No. 39919, U.S.N.M.

MELOCRINUS OBLONGUS Wachsmuth and Springer.

Melocrinus oblongus WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, 1897, p. 300, pl. XXII, figs. 9, 12.

An unlabeled specimen in the Troost collection is evidently of this species. It retains the basals and the plates of two rays as far as the arm bases.

Formation and locality.—Brownsport limestone. No locality is given for the specimen, but the matrix and manner of preservation indicate that it is probably the same as that of other specimens of *Melocrinus* in the Troost collection, that is: Decatur County, Tennessee. Wachsmuth and Springer give St. Paul, Indiana, and near Louisville, Kentucky, as localities for the species.

Cat. No. 39981, U.S.N.M.

Family EUCALYPTOCRINIDÆ Roemer.

Genus EUCALYPTOCRINUS Goldfuss.

The original description by Troost is as follows:

It is with pleasure that I embrace the opportunity afforded me by my situation in the midst of a rich fossil region wherein circumstances have placed me, to throw some light upon an interesting and beautiful fossil of which several hitherto unknown species occur in the State of Tennessee, belonging to a genus which as far as I know (The works that speak of this genus, known to me, are Goldfuss's Petrefacta and Phillips in Murchison's Silurian System) has been imperfectly described. Goldfuss who first described it under the name of *Eucalyptocrinites*, having a very mutilated specimen from Eifel, imagined that it had no column, and consequently gives an erroneous description of

it (see Goldfuss Petref. vol. 1, pag. 211 Tab. 64, fig. 7) in his magnificent work on German fossils. Soon nevertheless becoming acquainted with perfect specimens, he found out his mistake and published another description of the fossil in Acta Acad. Cæs. Leop. Carol. Nat. Cur. vol. XIX Pl. 1, Tab. XXX fig. 6. I never saw that description, and it is therefore not certain whether my description will contain any new fact, except the description of some American species and perhaps confirmation of facts which were yet doubtful. In fact it could not be expected that I, in the centre of the United States, remote from scientific communication and intercourse, should be acquainted with matter published in the Acta of the Imperial Academy when even Prof. Phillips was not acquainted with it. He describes in Murchison's Silurian system the same fossil as a new genus and gives it the name of *Hypanthocrinites*. The specimen described by Phillips though more perfect than that from which Goldfuss's first description was drawn up, was still incomplete, and in my opinion not fit to exhibit its true generic characters. I have been more fortunate than the above named naturalists. Decatur County in Tennessee, which I consider as our American Eifel, has furnished me with specimens which are almost perfect, constituting several species different from those incompletely described in Europe.

I will commence with making some remarks upon the generic characters as given by Goldfuss in his German fossils and by Phillips in Murchison's Silurian system. As already observed Goldfuss considering it as being deprived of a column, his description of the base or pelvic plates must be erroneous. As for the arrangement of the several series of plates Goldfuss is correct. He speaks not of its superstructure of arms, hands etc., in which respect this fossil differs widely from any known crinoid. Phillips, it seems, was not acquainted with the pelvis, he does not speak of it in his description, he is nevertheless correct in considering that part of the lowest series of pentagonal plates that are visible externally on the cup, as a first series of costals [radials]. The generality of hands, fingers, etc., in the figure of Phillips, all but the summit are well represented. (Murchis. Sil. Sys. pl. 17, fig. 3.) The summit does not correspond with any of my specimens, in fact judging from some in which this part is perfectly preserved, such tuberculated termination above the fingers is impossible.

The descriptions of this genus published by Goldfuss and Phillips were then drawn up from incomplete specimens. My collection is rich, not only in perfect specimens but in several different species of this genus which all differ from the *Hypanthocrinites decorus*, and the *Eucalyptocrinites rosaceus*, from which I have drawn up the following characters.

Column, cylindrical, with pentagonal or rather pentapatalous alimentary canal [lumen], articulating surfaces with striated margin.

Pelvis, pentagonal (no division perceptible) cup shaped, rising immediately round the column where it articulates almost immediately with the costals [radials]; so that, if even a small part of the column remains attached to the pelvis, this junction of the costals to the pelvis is not visible.

I must here observe that the generic character of the pelvis is drawn up from a species on which the impression of the column is in a very deep cavity (in one specimen the depth of this cavity is 12 mil. met. while the whole length of the cup is only 22 mil. met.) where the impression occupies the whole bottom and consequently the lowest part of the cavity is circular, while soon, the slopes of the cavity being regulated by the pentagonal form of the pelvis, the cavity assumes a pentagonal shape. In some species the cavity shows itself circular at the base of the cup.

Costals [radials]—First series—five, irregularly hexagonal, they rest upon the sides of the pentagonal pelvis, and constitute in those species where the column proceeds from a deep cavity, the greatest part of the sides of this cavity. When arriving at the external rim or the base of the cup, they are bent outwards and upwards and constitute part of the sides of the cup, where they appear as short, or longitudinally compressed, hexagonal plates, while in fact they are very elongated.

In this description we see the generic and specific characters are blended together, but those acquainted with these fossils will easily separate them. As it respects the superior plates of the cup and their arrangement, my observations coincide with those of Goldfuss and Phillips.

Goldfuss gives no description of its superstructure of hands, fingers etc., Phillips says only "The summit of the scapular bears a conical plate which divides the arms and fingers of each pair." I suppose this must be the solid (not conical in any of my species) plate which reaches to the very summit of the fossil (see fig. of *E. ovalis*) and which I consider as a character distinguishing it from all the known genera of crinoidea, and must have been very imperfect in the specimen observed by Phillips or he would not have stated that "it had a contractile? proboscis which rises above the short plumose fingers, and which is surmounted with several rows of tubercles." These septa ("conical plates") it is true, originate at the summit of the scapulars [intersecundibrachs and second interbrachials] dividing the hands and rise above the fingers, [arms]—they are ten in number and join together at the very apex of the fossil forming a rosette or elevation in the center. These septa extending inwardly almost to the center of the body could not give a passage to a proboscis "surrounded with several rows of tubercles" in none of my specimens could I discover that the fingers [arms] were feathered—in fact I consider these fingers (as they are called) more or less analogous to the organs called ambulacra in the *Pentremites*—they were not movable as those on the generality of crinoids,—each pair is inclosed, from summit to base, between two solid plates, and their construction shows that if they had the faculty of moving it was in a feeble degree. The septa penetrate into the body to different depths—near their origin at the scapulars this depth is very small and soon increases in proportion to the distance above the rim of the cup, till before they reach the summit it arrives at its maximum where it leaves only a narrow passage in the centre, when the depth decreases again, till the whole space between two septa terminates in a point.

I must conclude these observations by stating that if the fossil examined by Prof. Phillips is such as mentioned in Murchison's system, our fossil described under the name of *Eucalyptocrinites* must belong to a different genus.

The differences noted seem insufficient for the establishment of a new genus and *Hypanthocrinus* is regarded as a synonym of *Eucalyptocrinus*.

EUCALYPTOCRINUS LINDAHLI Wachsmuth and Springer.

Plate 12, figs. 5, 6.

Eucalyptocrinites splendidus Troost (not Hall and Whitfield 1875), Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).

Eucalyptocrinus splendidus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 371 (catalogue name).

Eucalyptocrinus lindahli Wachsmuth and Springer, Amer. Geol., X, 1892, p. 139; North Amer. Crinoidea Camerata, 1897, p. 347, pl. LXXXII, fig. 9.

Eucalyptocrinus wortheni Miller and Gurley, Illinois State Mus. Nat. Hist., Bull. 3, 1893, p. 53, pl. IV, fig. 2.

The following description is by Troost:

This magnificent crinoid, one of the ornaments of my collection, has a low, inverted conical cup, a cylindrical column with small pentalobed alimentary canal [lumen]; the articulating surfaces of its joints are slightly striated at the margin. The plates composing the body are slightly convex and corrugated which character is beautifully displayed in juvenile specimens. In this species the cavity in which the column is inserted is not very large. The hands and fingers [arms] are cylindrical and project

beyond the solid dividing septa. The summit in this specimen is more or less injured, several of the septa are fractured, but there is a sufficient number to show that these septa, when they have attained the summit increase in breadth, take a horizontal direction, and unite into one, forming a solid circular plate in the centre. It is $2\frac{1}{2}$ inches long and $1\frac{3}{5}$ inches in diameter.

This specimen which is almost perfect, together with the cup of another species and the *E. ovalis*, have served to determine the generic characters detailed above.

Observations.—The specimen which Hall identified as *Eucalyptocrinus splendidus* of Troost differs from Troost's specimen in the greater length of the calyx in proportion to the length of the arms, and in the fact that the backs of the plates between the arms are not parallel but converge toward the top. The name, having been published with a description by Hall, must be retained for his species. Troost's species was described from another specimen by Wachsmuth and Springer in 1892 and his specimen, therefore, takes the name which they proposed.

Formation and locality.—Brownsport limestone. Wayne and Decatur counties, Tennessee.

Cat. No. 39962, U.S.N.M.

EUCALYPTOCRINUS OVALIS Hall.

Plate 11, fig. 3.

Eucalyptocrinites ovalis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Eucalyptocrinites tennesseeæ Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Eucalyptocrinus ovalis Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 370 (catalogue name).—Hall, 28th Rep. New York State Mus. Nat. Hist., 1st ed., 1874, p. 143, pl. xvii, figs. 12, 13 (as *E. ovatus* in error; rectified in 2nd edition).—Wachsmuth and Springer, Rev. Paleocrinoidea, III, 1885, p. 134 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 244 (catalogue name).—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1899, p. 344, pl. lxxxii, figs. 1 to 6.

Eucalyptocrinus tennesseeæ Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 370 (catalogue name).—Wachsmuth and Springer, Rev. Paleocrinoidea, III, 1885, p. 134 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 244 (catalogue name).

The following description of *Eucalyptocrinus ovalis* is by Troost:

It differs from the *E. splendidus* in being not so elongated and its plates being not convex but flat. The cavity for the insertion of the column is circular, not deep and is surrounded by numerous small circular pits, which though they are found on all the individuals of this and of another species, I consider as accidental, perhaps made by a parasite. The hand and fingers [arms] do not project beyond the general level and are externally flat. The solid dividing septa are beautifully united into one at the apex forming a circular plane, more or less concave, having in the centre a circular elevation, the whole having the form of a rosette. Each pair of fingers [arms] which are slightly lanceolate, fit exactly between two septa. If these fingers were removed, the body would have some resemblance to an apple or orange out of which ten longitudinal sections were cut without going to the core.

It is entirely siliceous. The smallest marks on the fingers and the summit have been preserved during fossilification. They are not at all mutilated, but no feathers or tentacula [pinnules]'on the fingers are perceptible.

The single specimen of *Eucalyptocrinites tennesseeæ* in the Troost collection is indistinguishable from *E. ovalis*. Troost's description of *E. tennesseeæ* is as follows:

The body of this species is hemispherical and its surface is smooth. The cavity for the insertion of the column is circular and in proportion much larger than that of the *E. splendidus* with which it has some resemblance. The fingers are externally round and do not project beyond the general level, as is the case with the *E. splendidus*. It can not be a juvenile of the latter; I possess a juvenile cup of it which is in every respect similar to the adult—it is inverted conical and corrugate, and not hemispherical and smooth like the *E. tennessee*.

Observations.—*Eucalyptocrinus ovalis* is characterized by the regularly oval outline of the body, small circular basal excavation, and smooth surface.

Formation and locality.—Brownsport limestone. Decatur and Perry counties, Tennessee; Waldron and Hartsville, Indiana.

Cat. Nos. 39952, 39954, 39960, U.S.N.M.

EUCALYPTOCRINUS EXTENSUS Troost.

Plate 13, figs. 9, 10.

Eucalyptocrinites extensus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Eucalyptocrinus extensus Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 370 (catalogue name).—Wachsmuth and Springer, Rev. Pakeocrinoidea, III, 1885, p. 128 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 244 (catalogue name).

The description by Troost is as follows:

The cup is low basin shaped. The cavity for the column pentagonal, not very large—the plates tumid.

Supplementary description.—Only the calyx of this species is preserved. Its height to the level of the arm bases is 20 mm. and its greatest diameter 34 mm. The cup is distinctly flattened in the region of the first primibrachs, which causes the outline of the sides to be concave below and convex above. The body is also very slightly flattened in the region of the intersecundibrachs and the second interbrachials. The plates are slightly convex, with sutures distinctly visible but not beveled.

In one ray the first interbrachial is wanting, an abnormal feature of frequent occurrence among Crinoidea.

Surface smooth.

The basal excavation is but little larger than the column and distinctly pentagonal, with the angles of the pentagon directed radially.

Observations.—This species resembles *E. turbinatus* in form and size but differs in its convex instead of concave plates and in the

absence of beveled sutures. The surface also differs in being smooth instead of "covered with radiating ridges or rows of tubercles."

The form suggests that of *E. magnus*, but it differs from that species in the fact that the flattening of the sides is radial instead of interradial. Also, the second secundibrach is much smaller than the first and quadrilateral, its upper side forming a straight line on which rest two small tertibrachs.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39961, U.S.N.M.

EUCALYPTOCRINUS MILLIGANI Miller and Gurley.

Plate 5, fig. 13.

Eucalyptocrinites conicus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849),1850, p. 61 (*nomen nudum*); MSS., 1850.

Eucalyptocrinites floridus Troost, MSS., 1850.

Eucalyptocrinus conicus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 370 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 128 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 244.

Eucalyptocrinus milliganæ Miller and Gurley, Bull. No. 10, Ill. State Mus. Nat. Hist., 1896, p. 88, pl. v, figs. 4, 5, 6.

The following description of *Eucalyptocrinites floridus* is by Troost:

The whole surface of this specimen is injured; no articulations of the plates that compose the cup are perceptible, and the summit is still more damaged. I can only say that in its general form, it resembles the *E. splendidus*, [*E. lindahli*] but its cup is more acute conical; the pairs of fingers [arms] are lanceolate terminating almost in a point near the summit. An essential character which this species possesses, and which distinguishes it from all the Tennessee species of *Eucalyptocrinites*, is that the septa which separate the pairs of fingers, [arms] increase in thickness in proportion as they approach the summit and in proportion as the fingers decrease in breadth, so that the loss which is suffered by the fingers is made up by the increase of the size of the septa and consequently the diameter of the whole remains uniform to near the summit. Examining the figure of the *E. splendidus* [*E. lindahli*] we see that this is not the case with that species, the septa near the summit are of the same dimension as near the cup, and the finger diminishing in size, the diameter of the superior part of the fossil must in the same ratio become smaller.

Observations.—*Eucalyptocrinites floridus* Troost is apparently of the same species as *E. milligani* Miller and Gurley. The constriction of the body is less pronounced than in the specimens figured by Miller and Gurley (plate 5, fig. 5). The upper portion of the arms with the intervening plates is not preserved in Troost's specimen, but enough remains to show that the long interbrachial plates divide above and separate, but less widely than those shown in the figures of Miller and Gurley.

Three small calices described by Troost as *Eucalyptocrinites conicus* are referred to this species on account of the general resemblance in form and in the character of the basal excavation, although they do

not show a marked constriction of the body wall. This is apparently not a constant feature for the species, as indicated by Miller and Gurley's fig. 6, plate 5, in which such constriction does not appear.

Doctor Troost's description of these specimens is as follows:

The form of this species resembles that of *E. phillipsi* but the plates are tumid [?] and the cavity for the insertion of the column is circular [?] and not deep.

Although the plates have undergone considerable solution, which has removed much of the surface, they appear, contrary to Troost's observation, to be flat plates without ornamentation. The basal excavation also appears pentagonal rather than circular.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. Nos. 39957, 39958, U.S.N.M.

EUCALYPTOCRINUS PHILLIPSI Troost.

Plate 10, figs. 9, 10; Plate 13, figs, 2, 3, 4.

Eucalyptocrinites phillipsi Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Eucalyptocrinites lævis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS. 1850.

Eucalyptocrinus phillipsi Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 370 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 128 (catalogue name).

Eucalyptocrinus lævis Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 370 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 128 (catalogue name).

The following description is by Troost:

It is inverted conical. The cavity for the insertion of the column formed by the pelvic [basal] plates and part of the first costals [radials] is pentagonal, being very large and deeper than in any other species, it being 12 mil. met. deep while the height of the cup is 22 mil. met.

The specimens referred to *Eucalyptocrinites lævis*, apparently differ from *E. phillipsi* only in the narrower orifice of the basal excavation, but as this is a variable feature it seems insufficient ground for separating them as distinct species.

The following is Troost's description of *E. lævis:*

It is basin shaped and its surface smooth. The cavity for the column is pentagonal. In juvenile specimens the surface is crenate.

This species is subject to various modifications in height whilst preserving the same diameter. This being the only difference it can not be considered a sufficient reason for forming different species.[a]

[a] Fig. 50 [2, 3, 4, plate 13] I consider as a variety of *E. lævis*—Externally it resembles the *E. lævis* except that it is somewhat more inverted conical, but the visceral cavity is in proportion much smaller, the superior rim very broad and the inside pentagonal, whereas in the large specimen the sides are thin and circular.—From the same locality.

In the description of the *E. ovalis* I stated that small circular pits surrounded the lower part of the body and that I considered them as the work of parasites. It is the same with this species, most of the specimens are surrounded by these excavations the largest of which have a diameter of four mil. met. If it is the work of parasites, they must have taken hold of these animals when young because I found them on very small specimens of this species. I found them on three species while all the other species are free of them.

Observations.—The circular pits mentioned by Troost are a conspicuous feature of the specimens, and they are probably due, as he suggests, to the work of a parasite, but it is not known what organism produced them.

The differences between the specimen represented by figs. 2, 3, 4, plate 13, and others referred to the species are mainly due to conditions of preservation, and there seems to be no good reason for separating it as a variety.

Eucalyptocrinus phillipsi has the general form of *Eucalyptocrinus crassus* with straight sides and truncated base, but differs to a marked degree in the character of the basal excavation. In *E. phillipsi* the excavation is deep and sharply pentangular.

The basals are long and narrow, occupying about one-third the depth of the basal excavation. About one-half the length of the radial is required to complete the cavity, at the margin of which the radial bends abruptly upward at an angle of about 70° with its lower half. Other plates of the calyx are arranged as in *E. crassus*. The second secundibrach differs, in form from that of *E. crassus* in being a quadrilateral plate with width about twice the height and the upper edge forming a straight line. The plates are not preserved above the first pair of tertibrachs.

The surface is smooth.

Column small and circular with pentalobate lumen.

Formation and locality.—Brownsport limestone, Eucalyptocrinus zone of the Beech River formation. Decatur County, Tennessee.

Cat. Nos. 39963, 39964, 39965, 39966, U.S.N.M.

EUCALYPTOCRINUS GOLDFUSSI Troost.

Plate 15, figs. 5, 6.

Eucalyptocrinites goldfussi Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849) 1850, p. 60 (*nomen nudum*); MSS., 1850.

Eucalyptocrinus goldfussi Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 370 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 128 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 244 (catalogue name).

The following description is by Troost:

The cup is almost hemispherical but more flattened at the base than any other of the Tennessee species—in fact the whole of first series of costals [radials] and the lower part of the second series together with the lower part of the large heptagonal [decagonal] intercostal, contribute all to form the bottom of the cup, consequently

the sides are not much elevated. It is externally smooth—the cavity for the column pentagonal. This species having a smooth surface displays remarkably well the form of the plates which compose the cup. This species has likewise the circular pits mentioned in the descriptions of the *E. ovalis*, and the *E. laevis* [*E. phillipsi*].

I have dedicated this species to my friend Prof. Goldfuss of Bonn who first took note of this genus.

Supplementary description.—This is a well characterized little species with a low cup and broad base. The basals are small, about two-thirds of their length being concealed by the column. Radials small, invisible in a side view, about half their length bent abruptly inward to form the basal excavation. The lower half of the radials is also bent at a sharp angle in a longitudinal direction, which gives the distinctly pentangular form to the basal cavity. Plates above the first primibrachs concave, the intersecundibrachs and second interbrachials strongly so, which gives a slightly crenate outline to the upper surface of the calyx.

Under a lens the surface is seen to be finely granulose.

Observations.—This species is nearest to *Eucalyptocrinus depressus* Miller, but differs in the much narrower base, nearly straight sides, and in the character of the basal excavations. In *E. depressus* this is a broad shallow depression including nearly the whole surface of the large radials, while in *E. goldfussi* it is small, deep, pentagonal, and includes only the lower half of the radials. The plates of the former are also said to be convex and rugose.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39953, U.S.N.M.

EUCALYPTOCRINUS NASHVILLÆ Troost.

Plate 15, figs. 7, 8.

Eucalyptocrinites nashvillæ Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849) 1850, p. 60 (*nomen nudum*); MSS., 1850.

Eucalyptocrinus nashvillæ Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 370 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 128 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 244 (catalogue name).

The description by Troost is as follows:

It is an elongated cup with a narrow bottom and a deep circular cavity for the insertion of the column. Part of the hexagonal costals [radials] form part of the sides of the cup.

Observations.—This little species is distinguished by the form of the body and the character of the basal excavation. The aperture of the latter occupies nearly the entire width of the base. The cavity is at first shallow, but near the column it bends abruptly inward, forming a second depression, which is cylindrical and is nearly filled by the column.

The basals are very minute, only their outer angles projecting beyond the column. The radials are traversed for about half their length by a median groove which terminates in a dilation at about the center of the plate. The faint ridges around these dilations form the angles of the pentagonal basal excavation.

The species recalls *Eucalyptocrinus nodulosus* Weller in the character of the base, but is distinguished from the latter by the minute basals and the absence of surface ornamentation. It is also much smaller than Weller's specimens.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39955, U.S.N.M.

EUCALYPTOCRINUS VENTRICOSUS Wachsmuth and Springer.

Eucalyptocrinites crenatus Troost, MSS., July, 1850.

Eucalyptocrinus coelatus Roemer (not Hall, 1843), Sil. Fauna. d. westl. Tenn., 1860, p. 48, pl. iv, figs. 3*a–c*.

Eucalyptocrinus ventricosus Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 341, pl. lxxxiii, figs. 11, 12.

Troost's description of this species is as follows:

I possess only the cup of this species,—its surface is prettily ornamented with rosettes and rhomboidal figures slightly in relievo, by which all the points of the plates are obliterated. This specimen is interesting as it shows the difference between the plates that are supported by the large heptagonal [decagonal] intercostals [interbrachials] and those that proceed from the cuneiform arms; they each support a solid septum, but those that proceed from the heptagonal intercostals are double, while the others are single and not so broad.—This species shows also the great thickness of the shell and consequently the smallness of the internal cavity.

There seem to be no constant characters by which these specimens can be distinguished from those found by Roemer in western Tennessee.

Formation and locality.—Brownsport limestone, Eucalyptocrinus zone of the Beech River formation. Decatur County, Tennessee.

Cat. No. 39956, U.S.N.M.

EUCALYPTOCRINUS GIBBOSUS Troost.

Plate 10, figs. 3, 4.

Eucalyptocrinites gibbosus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*), MSS., 1850.

Eucalyptocrinus gibbosus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 370 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 128 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 244 (catalogue name).

The original description by Troost is as follows:

The form of the cup is intermediate between that of the *E. splendidus* and the *E. crenatus*, and it differs in some respects from all the species in my possession. Its arm plates which in all other species are incased in an almost rectangular excavation,

form here a segment of a circle or as Miller says "a horse shoe excavation." The cavity for the insertion of the column is pentagonal, not deep—column cylindrical—alimentary canal [lumen] pentalobate. The plates are tumid which gives it a bossed surface. The plates forming the superior rim must deviate somewhat from those of other species, but the gibbosity of them prevented me from detecting it.

Observations.—The most characteristic features of this species are given in Doctor Troost's description. The elevated rim around the base of the arms is formed by the convex surface of the second secundibrachs and the edges of the intersecundibrachs and interbrachials.

The tumid plates of this species suggest *Eucalyptocrinus decorus* Phillips, but the calyx is proportionally much higher. They also recall *Eucalyptocrinus inornatus* Weller, but the latter has a lower cup with more curved sides, and it lacks the elevated rim below the arms.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39959, U.S.N.M.

Family DOLATOCRINIDÆ Bather.

Genus DOLATOCRINUS Lyon.

Cacabocrinites Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).

Cacabocrinus Hall, 15th Rep. N. Y. State Cab. Nat. Hist., 1862, p. 109.

Dolatocrinus Lyon, Geol. Rep. Kentucky, III, 1857, p. 482.—Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 367 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 124.—Miller, North Amer. Geol. and Pal., 1889, p. 240.—Zittel, Text-Book Pal. (Eastman trans.), 1896, p. 148.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 310.—Bather, A Treatise on Zoology, III, The Echinoderma, 1900, p. 164.

The following is Troost's description of *Cacabocrinites:*

GENERIC CHARACTERS.

Pelvis [base] pentagonal, divided into five.

Costals [radials] pentagonal, five.

Scapulars [first primibrachs] sub-hexagonal, five. The inferior angle re-entering superior angle salient.

Arms ten.

DOLATOCRINUS GRANDIS Miller and Gurley.

Plate 12, fig. 2.

Cacabocrinites sculptus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Dolatocrinus grandis Miller and Gurley, Bull. No. 4, Illinois State Mus. Nat. Hist., 1894, p. 14, pl. II, figs. 1, 2, 3.

The following description is by Troost:

A low hemispherical cup having a deep, pentagonal, funnel shaped cavity for the insertion of the column. This cavity is surrounded with five prominent tubercles,

resembling the supports or feet of the culinary utensil called "skillet" from which is derived the name of cacabs (*cacabus*). The superior rim is cut out with ten semicircular apertures for the arms. The whole surface is corrugate with sharp wrinkles.

Pelvis [base] funnel shaped, pentagonal, divided into five. These pelvic [basal] plates are irregular elongated hexagonal, and line the sides of the funnel shaped cavity which, in the specimen here described, is about 2 cent. met. deep and has a diameter of 15 mil. m. at the top and 4 mil. m. at the bottom consequently it is an inverted truncated pyramid giving to these plates an elongated triangular appearance. These pelvic plates show only a very small part on the surface of the cup; merely a straight edge having both extremities beveled—these bevels forming with those of the next adjacent pelvic plates a reentering angle. Upon the above mentioned straight edge rest five—

Costals [radials]—they are short, pentagonal, very much elevated in the centre, presenting a prominent tubercle as stated above, the superior salient angles support five—

Scapulars [primibrachs], are longitudinally compressed hexagonal plates, two parallel sides forming the lateral margins, one of the angles forms the apex while the opposite angle forming the base is a re-entering angle—this re-entering angle is filled by the superior angle of the pentagonal costal [radial] while the superior, a salient angle, supports two irregular pentagonal plates, which are followed by two similar ones, and terminate in two arms, having circular apertures round the rim.

Five inter-costals [interbrachials] of an elliptic form, rendered more or less angular, by the adjacent plates, or they are polygonal rendered elliptical by the corrugation—they fill up the re-entering angle mentioned above and are surrounded on both sides by the costals [radials], scapulae [primibrachs], and by the plates which rest upon the hexangular scapulae and support two elongated hexagonal inter-scapulae [second interbrachials].

Inter-scapulae [second interbrachials] 10, of an elongated hexagonal form—they support first two small plates, upon which follows a row of four still smaller plates; upon these follows a horizontal beveled edge filling the space between two apertures for the arms and completing in this manner the superior rim of the cup.

The capital integument as well as could be discovered from my imperfect specimen, is formed of polygonal plates of which the form could not be ascertained, they are carved somewhat similar to those of the cup.—No oral [anal] aperture is visible, it existed probably on the part that is destroyed.[a] Around the margin, between two arms and between each pair of arms [radi] are series of elongated pores—between two arms generally five, and between each pair of arms seven, these numbers vary, nevertheless the number between each pair is always the largest.

Observations.—Could Troost's description have been published at the time it was presented this fine specimen would have been the type of the genus, but, as shown by the synonymy, Hall's publication of the diagnosis did not appear until 1862, and the species also has been described by others.

This species is closely related to *Dolatocrinus excavatus* Wachsmuth and Springer, but according to the descriptions it differs in having 8 to 10 pores between the arms while the latter has 4 to 6 pores.

[a] Since the above description was drawn up, I have seen a specimen of this fossil in the collection of Doctor L. P. Yandell which has its capital integument more complete than my specimen, from which it appears that it is covered with numerous small polygonal plates in the form of a dome having a central oral [anal] aperture surrounded with a few small plates, slightly elevated above the general level.

It also differs in minor features of the surface ornament. A comparison of the types might show them to be of the same species.

Formation and locality.—Hamilton. Falls of the Ohio.

Cat. No. 39912, U.S.N.M.

Suborder BATOCRINOIDEA Bather.

Family COELOCRINIDÆ Bather.

Genus AGARICOCRINUS Troost.

Agaricocrinus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.—HALL, Geol. Rep. Iowa, I, Pt. 2, 1858, p. 560.—SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 351.—MEEK and WORTHEN, Geol. Rep. Illinois, II, 1866, p. 210.—WACHSMUTH and SPRINGER, Proc. Acad. Nat. Sci. Phila., 1878, p. 350; Rev. Palæocrinoidea, II, 1881, p. 109.—ZITTEL, Text-Book Pal. (Eastman trans.), 1896, p. 143.—MILLER, Bull. No. 12, Illinois State Mus. Nat. Hist. 1897, p. 9.—WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, 1897, p. 486.—BATHER, A Treatise on Zoology, III, The Echinoderma, 1900, p. 167.

Amphoracrinus ROEMER (not Austin), Leth. Geognostica, 1855, p. 250.—HALL, Boston Jour. Nat. Hist., 1861, p. 280.

The original description is as follows:

This crinoid differs so much in its form from the generality of these fossils, that even, without regard to the peculiar combination of its plates, its form alone would entitle it to rank as a new genus. The column being attached in the bottom of an inverted basin and all the plates proceeding from the pelvis which forms the center of the basin, running downward, give it the appearance, when a stem is attached to it, of a parasol or mushroom (*agaricus*, whence its name). The coronal integument which surrounds this basin is composed of hemispherical tubercles, and has the form of a cone or of a pentagonal pyramid.

GENERIC CHARACTERS.

Pelvis [base] hexagonal divisible into three parts.

Column cylindrical with striated articulating surface and pentapetalous alimentary canal [lumen].

Costals [radials and anal plate] six, hexagonal.

Scapulars [first primibrachs] five, pentagonal.

Interscapulars [interbrachials] seven, elongated subhexagonal.

Observations.—This description of the genus was published by Hall [1858, p. 560] in connection with his description of *Agaricocrinus bullatus* from Burlington, Iowa. On page 617 of the same report he publishes a description of *Agaricocrinus tuberosus*, using as a type a specimen from Keokuk, Iowa, merely referring in his synonymy to the description of Troost which was in his hands at the time. Apparently none of the specimens in Doctor Troost's collection agree with Hall's *A. tuberosus*, as noted in the following descriptions of the species, but *A. tuberosus* is the species mentioned by Hall as the type of the genus, and according to the accepted rules of priority it must remain so, although the name now applies to a different species from the one designated by the author of the genus.

Hall considers *A. tuberosus* Hall and *Amphoracrinus americanus* Roemer as possibly synonymous, but they differ in the number of arms and in other important respects as noted by Miller and Gurley [1897, p. 11] and Wachsmuth and Springer [1897, p. 490].

AGARICROCRINUS AMERICANUS Roemer.

Plate 5, fig. 9.

Agaricocrinus tuberosus Troost (in part), Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Amphoracrinus americanus Roemer, Lethaea Geogn. (3rd ed.), 1855, p. 250, pl. IV, figs. 15*a*, *b*.

Agaricocrinus americanus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 351 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 228 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 220 (catalogue name).—Gordon, Amer. Geol., V. 1890, p. 261, figs. 2–5; Proc. Iowa Acad. Sci., I, Pt. 1, 1890, p. 101.—Keyes, Missouri Geol. Surv., IV, 1894, p. 168, pl. XXII, figs. 8*a–b*.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 488, pl. XLII, figs. 1, 2*a*, *b*.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 67 (catalogue name).

The following description is by Troost:

The pelvis [base] is concave, bearing a circular impression of a cylindrical column, the articulating surface of which is striated.

Costals [radials and anal plate], six, hexagonal, placed upon the six sides of the pelvis, forming a hexagon with six re-entering angles.

Scapulars [first primibraches] five, pentagonal [quadrilateral], placed upon the hexagonal costals [radials].

Interscapulars [interbrachials], seven, elongated subhexagonal, six being placed in the re-entering angles of the costals [radials] and one is placed like the scapulars upon one of the hexangular costals [anal plate]. These elongated plates, descending to the border of the basin, surrounding [passing over] it and passing between the arms, terminate at the plates which compose the coronal integument, four of them pass singly between four pair of arms, while the other three, namely, the one which is placed upon the costals [anal plate] and two which are placed in the re-entering angles, pass between a single pair of arms, which are more remote from each other, and terminate all three, below two small plates, belonging to those that surround the oral [anal] aperture.

The five scapulars [first primibrachs] support an equal number of subhexangular [?] arm plates [second primibrachs] each having one re-entering and five salient angles, [?] in the former is inserted the superior angle of the scapulars [first primibarchs]. The arm plate [second primibrach] supports on each bevel a low cuneiform plate upon each bevel of which are placed three or four small plates which support a hand [arm]; the number of these hands [arms] is not uniform. From the two arms, between which pass the three elongated plates above mentioned, we have four hands, while the three other arms have generally only two, sometimes one of them has three hands [arms]. This irregularity seems to be accidental—the arms being probably liable to fracture, were then replaced by new ones, which were smaller and the fingers fewer in number. At other times two hands [arms] are joined together. In the latter case the plates are irregular and the number of hands correspond with that of a single arm. All this irregularity must be attributed to accidents during the life of the animal. The large size nevertheless of the two arms between which project the three elongated plates and between which the oral [anal] aperture is placed seems invariable and they have constantly four hands [arms].

The division of hands and fingers is unknown.

The capital integument [tegmen] which is large, hemispherical or sometimes pyramidal, is composed of large tumous plates and terminates at its apex in a still larger hemispherical plate. The whole of its surface seems to have been covered with a finely granulated integument. It had no proboscis, but a prominent oral [anal] aperture, surrounded with numerous small tumous plates, which is placed a little above the junction of the two large arms.

It is very uncommon to find specimens which exhibit all the characters here enumerated. The basin shaped concave body, which is composed of the characteristic plates, is generally filled with siliceous matter; in fact, the whole fossil is siliceous. I possess only one specimen (a juvenile one) in which the plates are distinct.

I discovered only one species of this genus, and only at one locality, namely, near White's Creek Springs, so rich in encrinital remains.

Observations.—Doctor Troost described under the name of *Agaricocrinus tuberosus* five species of *Agaricocrinus*. The description, however, with the exception of the part relating to the number of arms, is evidently taken from a specimen now referred to *Agaricocrinus americanus*. In this specimen the plates of the calyx are clearly shown, and Troost's description of them is accurate except in the description of the primibrachs, where he apparently confuses rays in which the first primibrach is abnormally wanting with the normal rays. The specimen is a fourteen armed individual which corresponds with the description and figures of Roemer except in the depth of the basal excavation. The latter is much deeper in the specimen at hand than in the one figured by Roemer, but as this feature varies considerably in individuals undoubtedly of the same species it can not be relied upon for specific separation.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee.

Cat. No. 39889, U.S.N.M.

AGARICOCRINUS ARCULA Miller and Gurley.

Agaricocrinus tuberosus TROOST (in part), Proc. Amer. Ass. Adv. Sci., II (read 1849), p. 60 (*nomen nudum*); MSS., 1850.

Agaricocrinus arcula MILLER and GURLEY, Bull. No. 6, Illinois State Mus. Nat. Hist., 1895, p. 30, pl. III, figs. 7, 8.—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 67 (catalogue name).

Among the specimens described as *Agaricocrinus tuberosus* Troost (MSS.) is a small ten armed individual which has been referred to *A. arcula* Miller and Gurley. The chief difference between the specimen and Miller and Gurley's type is that the primaxils and succeeding secundibrachs are slightly convex instead of being flattened. In other respects it agrees closely with the type.

The tumid plates at the base of the arms form a conspicuous feature of the tegmen. They are nearly or quite as large as the posterior oral.

This species differs from *A. tuberosus* Hall in the number of arms and from both that species and *A. bullatus* in the short first interbrachials which are followed by two relatively broad plates. It is also smaller than *A. tuberosus* Hall.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee.

Cat. No. 39973, U.S.N.M.

AGARICOCRINUS CRASSUS Wetherby.

Plate 14, figs. 5, 6.

Agaricocrinus tuberosus Troost (in part), Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Agaricocrinus crassus Wetherby, Journ. Cincinnati Soc. Nat. Hist., IV, 1881, p. 178, pl. v, fig. 1*a*, *b*.—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 105.—Miller, North Amer. Geol. and Pal., 1889, p. 220.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 499, pl. xxxix, figs. 2*a*, *b*; pl. xl, fig. 4.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 69 (catalogue name).

Observations.—One of Troost's specimens of *Agaricocrinus* agrees with *A. crassus* Wetherby in the number and arrangement of the plates, the number of arms, the flattened base, and the wide anal area with projecting arms. The chief difference from Wetherby's type is in the greater convexity of the plates of the latter, but Troost's specimen is silicified and the outer layer entirely removed, so that the plates may have been more convex than now appears.

The present specimen shows long first brachials which reach to the top of the arm bases, differing in that respect from the figure of the species given by Wachsmuth and Springer [1897, plate 39, fig. 2*b*]. The original description is meager, relating mainly to the general form and the plates of the tegmen, but the type figure shows a specimen with first interbrachials bending over the margin of the calyx, and the second interbrachials are not visible in a side view.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee.

Cat. No. 39974, U.S.N.M.

AGARICOCRINUS PONDEROSUS, new species.

Plate 14, figs. 1, 2.

Agaricocrinus tuberosus Troost (in part), Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).

This fine species has a deep basal excavation and a tegmen of moderate height leaving a restricted space for the animal.

The basals and radials at the bottom of the basal excavation are concealed by the matrix. First primibrachs rectangular and nearly twice as wide as long. Primaxils large, irregular in shape, followed by one secundibrach on each side in the posterior rays and on the posterior side of the antero-lateral rays. The secundibrachs are followed by two series of tertibrachs, from each of which an arm arises. On the anterior side of the antero-lateral rays and in the anterior ray

the primaxil is followed by three or four secundibrachs, of which the distal plate gives rise to an arm. This gives the following arm formula for the species:[a] 1–1 . . . 1–2 . . . 2–2 . . A . . 2–2 . . . 2–1. The arms are not preserved.

The first interbrachials are long, reaching from the superior angles of the radials to the top of the arm bases. Unlike most species of *Agaricocrinus*, the first interbrachials are followed by three plates, which form a part of the tegmen. A single plate truncates the distal end of the interbrachial, and two large plates abut against its superior lateral slopes. The anal plate is concealed by the matrix. It is followed by three large plates, which curve over the margin of the calyx and unite with plates of the tegmen.

Tegmen of heavy, nodose plates. Orals in contact. Posterior oral nearly twice as large as the others and more convex. Interambulacral plates comparatively small and but slightly convex. Anal aperture about one-third the distance from the apex to the base of the tegmen, and situated at the center of an oval, moderately elevated prominence.

The surface of the plates within the basal excavation appears smooth, but on the arm bases and the tegmen it is rather coarsely granulose.

Observations.—This species is most closely related to *A. nodulosus* Worthen, but is distinguished by the absence of nodose calyx plates and by the presence of very long first interbrachials, which are followed by one instead of two plates. *A. keokukensis* Miller and Gurley, which has the same number of arms, has very small primaxils and strongly nodose secundibrachs, and the interbrachial areas are occupied by three small plates following one another in radial series.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee.

Cat. No. 39975, U.S.N.M.

AGARICOCRINUS ATTENUATA, new species.

Plate 14, figs. 3, 4.

Agaricocrinus tuberosus TROOST (in part), Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).

This species is characterized by a body of moderate size, with slender, projecting arm bases.

Basals nearly concealed by the matrix but apparently projecting a little beyond the column. Radials about equal in length and width. First primibrachs irregularly quadrangular, one corner being

[a] The arm formula used in this paper is the one proposed by the writer in the Smithsonian Misc. Coll., XLVII, 1894, p. 69, with the interpolation of the letter A in the position of the anal area for forms in which that structure is well differentiated.

drawn out to occupy the space between the wide primaxil and the adjacent interbrachial. Primaxils three times as wide as long. Secundibrachs but slightly smaller than the primaxils. In the anterolateral rays, which have three arms, the secundibrachs are followed on the posterior side by two series of tertibrachs, and on the anterior side by two additional secundibrachs, which support the arms. The posterior rays are symmetrical, having on each side one secundibrach followed by 2 x 2 tertibrachs. The plates of the anterior ray are not preserved beyond the first secundibrachs, but the arm formula for the species, so far as it can be determined, is ?–? . . . 1–2 . . . 2–2 . . A . . 2–2 . . . 2–1.

First interbrachials long, reaching from the radials to the top of the arm bases, and succeeded by two small plates, which form a part of the tegmen. Anal area of moderate width. Anal plate longer than the radials, succeeded by a plate of about half its size and by two large plates, which rest against its superior lateral slopes. These plates are followed by numerous small tegmen plates of indefinite arrangement.

The plates of the dorsal cup are convex but not nodose. The convexity renders the suture lines between the plates very distinct. The outer surface is not preserved.

The height of the tegmen is about equal to its greatest diameter. Orals in contact, large and moderately convex. Lines of nodose plates cover the ambulacral areas from the orals to the arm bases, terminating in two large plates on the four-armed rays, and in a large and small plate on the three-armed rays. A single large plate over the anterior ray indicates that it possessed only two arms. Interambulacral plates slightly or not at all convex. Anus situated about halfway between the base and the apex of the tegmen. Aperture not elevated above the general surface of the tegmen, but the plates just above the anus are raised into a slight swelling of the surface.

Observations.—This species has the projecting arm bases attributed to *Agaricocrinus crassus* Wetherby, but the whole structure of the crinoid is characterized by lightness and delicacy in contrast with the massive structure of *A. crassus*. The calyx plates above the radials are very short and wide, unlike those of *A. crassus*, and *A. attenuata* has no anal protuberance.

A. elegans Wetherby agrees with *A. attenuata* in being less robust than *A. crassus*, but it differs in the number of arms, having three or four in the posterior rays and two in all the other rays. It also differs in having short first interbrachials and an extremely wide anal area.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee.

Cat. No. 39976, U.S.N.M.

Family BATOCRINIDÆ Bather.

Genus BATOCRINUS Cassiday.

BATOCRINUS GRANDIS Lyon.

Plate 15, fig. 11.

Actinocrinites urna TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*), MSS., 1850.

Actinocrinus grandis LYON, Amer. Journ. Sci., XXVIII, 1859, p. 240.

Actinocrinus urna SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 349 (catalogue name).

Actinocrinus wachsmuthi WHITE, Contr. Inv. Pal., No. 8, 1880, p. 162, pl. XL, figs. 1*a*, *b*; 2nd Ann. Rep. Dep. Stat. and Geol. Indiana, 1880, p. 510, pl. VII, fig. 6.

Batocrinus grandis WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, III, 1885, p. 113; North Amer. Crinoidea Camerata, 1897, p. 381, pl. XXVII, figs. 1*a*, *b*, 2*a*, *b*.—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 127 (catalogue name).

Troost's description of this species is as follows:

This species of *Actinocrinites* has the elegant form of a vase which is rendered more graceful by the elevation of the pelvic plates which form its base; and the great extension of its superior margin, which is circular and supports a dome-shaped coronal terminated in a proboscis, which completes its beauty.

The curve of the lower part of the body resembles that of the *A. 30 dactylus* [a] as represented by Miller (pl. 1, figs. 1 and 2) but at the height of the scapulars [primaxils] the plates assume a great extension in breadth—this extension continues to the very rim, from the edge of which proceed the 20 [?] fingers [arms] etc. the apertures of which are only visible when a side view is taken.

The plates of which the body is composed are elevated toward the centre—they have no elevated ridges, those that cover the coronal integument are tumous, polygonal. The whole was covered with a granulated integument part of which is yet attached here and there on the surface.

Judging from fragments which I have often found it must have grown to three times the size of the one figured.

Occurs abundantly near White's Creek Spring, where I found numerous fragments of it, but only one entire.

Observations.—The specimen labeled *Actinocrinites urna* by Troost corresponds with *Batocrinus grandis* (Lyon) in the features available for comparison.

The arms are not sufficiently preserved for the full number to be counted, but the left posterior ray shows six arms and the left anterolateral ray four, hence if the animal were symmetrical with four in the anterior ray it would have twenty-four arms, the number recorded for *Batocrinus grandis*.

Slight differences from *B. grandis* may be noted in the form of the tubercles on the radials and the size of the base of the proboscis, but these may well be merely individual variations.

[a] *Actinocrinites triacontadactylus* J. S. Miller, A Natural History of the Crinoidea, 1821, p. 95, pl. 1.—E. W.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Davidson County, Tennessee. The species is also recorded from Hardin County, Kentucky, and Crawfordsville, Indiana.

Cat. No. 39896, U.S.N.M.

BATOCRINUS GIBBOSUS (Troost).

Plate 15, fig. 9.

Actinocrinites gibbosus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).

Actinocrinus gibbosus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 344 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 224 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 218 (catalogue name).

The original description by Troost is as follows:

This species has much analogy with the *A. cornutus* [*Eretmocrinus praegravis*] but it differs from it in its form and the proportions of the different parts, the cup being in proportion more elevated and the coronal integument more flat—the proboscis less capacious, and showing the places of insertion of the fingers to the number of twenty [eighteen]. The tubercles, particularly upon the coronal integument, are less elevated and not so acute.

The specimen here represented, the only entire one that I have found, is wholly covered by a chalcedonic matter through which rise the tops of the plates, which are elevated. There is no doubt that the size of the body was thereby increased and its form, at least of the lower part, has been more or less changed, because the plates are now further separated laterally from one another than they were in the live state.

As the top of the plates are not covered, this siliceous exudation must have proceeded from the interior of the body, through the joints of the plates which has extended these joints. This fact I have observed in several of our fossils, and never on those that I received from Europe; I have even found some that were entirely covered by similar chalcedonic matter. The specimen now under consideration is totally siliceous but the projecting plates are flinty while the substance that fills up the space between the plates is chalcedonic.

Supplementary description.—Although the plates of this specimen have been widely separated by siliceous enlargement as described by Doctor Troost, they are well preserved and their form and arrangement can be determined.

As indicated by a careful measurement of the plates, the height of the calyx to the arm bases must have been about 35 mm., and the tegmen probably about half that height.

Basals large, bearing transverse nodes on which the crinoid would rest if deprived of its stem. Sutures strongly beveled. Radials large, wider than long. Plates of the radial series bearing transverse sharp ridges which extend nearly the whole width of the plates. Arm formula as follows: 1–2 . . . 1–2 . . . 2–2 . . A . . 2–2 . . . 2–2, giving eighteen arms to the species.

There is but one large interbrachial, which bears a rounded instead of a transverse node. The first anal plate also bears a rounded node,

and is followed by three plates above which there are apparently two plates, but this can not be determined with certainty.

The exact arrangement of the tegmen plates can not be made out, as they have been unequally separated by deposition of silica. Each plate bears at its center a sharp spine-like node. Proboscis unknown.

Observations.—This species resembles *Batocrinus honorabilis* Miller and Gurley in general form and surface ornament, but it differs in having but one instead of four interbrachial plates and in the presence of eighteen instead of twenty arms. It also resembles *B. grandis*, but differs from that species, as well, in the single interbrachial plate and fewer arms.

The resemblance to *Eretmocrinus praegravis* Miller is confined mainly to the nodes of the surface, which are, however, less prominent in the present species. The latter differs further from *E. praegravis* in having the dorsal cup much higher than the tegmen and in the greater number of arms.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Davidson County, Tennessee.

Cat. No. 39892, U.S.N.M.

BATOCRINUS SAYI (Troost).

Plate 13, figs. 7, 8.

Actinocrinites sayi TROOST, MSS., 1850.

The original description by Troost is as follows:

I am not certain whether this crinoid belongs to the *Actinocrinites*. The plates forming the cup of figs. [7 and 8] exhibit certainly the arrangement of this genus but it is widely different in regard to its capital integument; but as naturalists class these fossils according to the arrangement of the plates that compose these bodies, I place it together with *Actinocrinites fibula* [*Dizygocrinus sacculus*, pl. 5, figs. 1–6] which is equally doubtful, being placed provisionally in this genus.

It is basin shaped, composed of tumid plates. The arms which do not project beyond the rim, which is circular, are ten [?] in number. The capital integument is level, and does not terminate in a proboscis [?]. The centre is taken up by an irregular circular plate, the top stem joint which seems to have a circular aperture in its centre. The remains of the integument are covered with irregular polygonal plates each of which is elevated in its centre.

Supplementary description.—The single specimen representing this species is wholly silicified and much distorted by compression, but the lower plates of the calyx are well preserved.

Basals comparatively small, the upper half of each plate rising at right angles to the lower half and having its lateral angles truncated. The three basals together form a short hexagonal prism from which the radials diverge abruptly.

Radials very large. Greatest width of a single radial equal to the entire width of the basal prism. First primibrachs but slightly wider than long. Primaxils of about the same size as the first primibrachs, wider than long. First secundibrachs as large as the

primaxils. Higher plates of the calyx indeterminable. The number of the arms cannot be accurately determined, but there are at least twenty and probably more, as indicated by the size of the arm bases which are preserved and the portion of the periphery belonging to each ray.

There is apparently but one large interbrachial. First anal plate larger than the radials, followed by three smaller plates, and these by the two adjacent secundibrachs and three additional small plates.

All plates of the dorsal cup bear at the center a large, rounded, but not very prominent, node. Surface covered with fine granules.

Plates of the tegmen small in comparison with those of the dorsal cup, each bearing a sharp spine at its center. Less than half of the tegmen is preserved, hence the character of the proboscis is unknown.

Observations.—*Batocrinus sayi* is distinguished from other described species of the genus by the comparatively small base, the extremely large radial plates, and the presence of but one interbrachial. The species resembles *B. gibbosus* Troost in having but one interbrachial and in the spinose tegmen plates, although the spines of its tegmen are narrower and longer than those of *B. gibbosus*. It differs from the latter species in the size and shape of the basals and radials and in the form of the surface nodes which are rounded instead of transverse.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Davidson County, Tennessee.

Cat. No. 39899, U.S.N.M.

Genus ERETMOCRINUS Lyon and Casseday.

ERETMOCRINUS PRAEGRAVIS Miller.

Actinocrinites cornutus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).

Actinocrinus cornutus Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 343 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 224 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 217 (catalogue name).

Eretmocrinus praegravis Miller, Adv. Sheets, 18th Rep. Ind. Dep. Geol. and Nat. Hist., 1892, p. 37, pl. VI, figs. 5, 6.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 405, pl. XXXIV, figs. 9, 10.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 251 (catalogue name).

The description by Troost is as follows:

The crinoid now under consideration was at first taken for the *Melocrinites gibbosus* figured by Goldfuss, plate 64, which resembles more or less our fossil, it being very difficult to form a just idea of the form and arrangement of the plates. Yet notwithstanding this apparent irregularity it is easily seen that the pelvis [base] is composed of three parts, that it supports two series of six plates of costals [radials and anal plate], which support again five scapulars [primibrachs] with a cuneiform summit upon

which are composed arms and hands, the horseshoe formed joints, fifteen in number,[a] forming the upper rim of the body which is covered by a cone or coronal integument, surrounded with large projecting tubercles some of which are flattened and divided into three points. This capital integument terminates in an ample proboscis—and this proboscis, as I have never observed in any of the crinoids, is internally divided into three parts as if it was composed of three tubes having each a circular aperture[?]. This division is not accidental. I found it in all perfect probosces of this species. The proboscis is only 6 mil. m. long.

I found them at White's Creek Springs only, where the fragments of it are not uncommon, but I found only one perfect specimen.

Observations.—Doctor Troost's specimens of the species are large and characteristic individuals. The appearance of partitions within the anal tube, described by Troost, is produced in one of his specimens by the presence of two large, hollow spines which have been broken off near the point where the tube is itself broken off. The three apertures thus produced were mistaken by Troost for parts of the same tube.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee. Also found at Pilot Knob, near Louisville, and Barren County, Kentucky; Montgomery County, Indiana.

Cat. No. 39891, U.S.N.M.

ERETMOCRINUS SPINOSUS (Miller and Gurley).

Plate 11, figs. 1, 2.

Actinocrinites marincri TROOST, MSS., 1850.

Batocrinus spinosus MILLER and GURLEY, Bull. No. 6, Illinois State Mus. Nat. Hist., 1895, p. 5, pl. 1, figs. 1, 2, 3.—WELLER, Bull. No. 153 U. S. Geol. Surv., 1898, p. 134 (catalogue name).

The following description is by Troost:

The cup of this crinoid resembles more or less that of the *A. cornutus* mihi, [*Eretmocrinus praegravis* Miller], but it is more longitudinally compressed. It differs principally in the form of its capital integument which is low and in the form of a dome in the *A. cornutus*, whereas it is elongated and conical in the *A. marineri* and its proboscis is tuberculated to its very summit, whereas the summit of the *A. cornutus* is without tubercles.

It was discovered by Mr. George Mariner in Cannon County, Tennessee, Carboniferous.

Observations.—The single specimen representing Doctor Troost's species agrees exactly with that of Miller and Gurley except that it has three arms in the anterior ray instead of two.

Both Troost and Miller and Gurley call attention to the close resemblance between this species and *Eretmocrinus praegravis* Miller. The

[a] Such is the case with the specimen here described. I have a mutilated one which shows that the two arms proceeding from the scapulars are both divided forming four hands, if this subdivision continues, which the imperfect state of the specimen does not show, it would give 20 of these joints, while the specimen here described has only 15.—Troost.

latter authors separate the two species by the number of arms, describing fourteen arms for *Batocrinus spinosus* and twelve for *Eretmocrinus praegravis*. In the original description of *E. praegravis* some uncertainty is expressed as to the number of arms. Small apertures in addition to the twelve undoubted arm openings are mentioned as being possibly related to the arms. Wachsmuth and Springer describe definitely fourteen arms for *E. praegravis*, the same number possessed by *Batocrinus spinosus*. The dorsal cup of the latter is, however, lower, the anal tube larger, and the specimens also much smaller than *Eretmocrinus praegravis*, and it is therefore regarded as a distinct species.

Miller and Gurley assign their species to *Batocrinus* and suggest that the genus *Eretmocrinus* be abandoned, assuming that the genus is founded upon the size and curvature of the proboscis. As noted by Wachsmuth and Springer, *Eretmocrinus* differs from *Batocrinus* in the paddle-shaped arms, the projecting basals, the eccentric anal tube, and other well-marked features which entitle it to rank as an established genus. Since *Batocrinus spinosus* Miller corresponds with *Eretmocrinus* in all the features available for comparison and is closely related to *Eretmocrinus praegravis*, it should be referred to *Eretmocrinus* as is here done.

Formation and locality.—Keokuk horizon of the Tullahoma formation. Cannon County, Tennessee; Little Barren River, Kentucky.

Cat. No. 39895, U.S.N.M.

ERETMOCRINUS RAMULOSUS (Hall).

Actinocrinites agassizi Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 342 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 223 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 217 (catalogue name).

Actinocrinus ramulosus Hall, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 615, pl. xv, fig. 7.

Eretmocrinus ramulosus Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 173 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 243 (catalogue name).—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 387, pl. xxxvii, figs. 4*a*, *b*, 5*a*, *b*, *c*, *d*.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 251 (catalogue name).

The following description is by Troost:

This species is distinguished from *A. urna* [*Batocrinus grandis*] in the curve of the cup which in the *A. agassizi* [*Eretmocrinus ramulosus*] is more uniformly rising and not expanded at the rim, the plates are tumous but less elevated than in the *A. urna* and are ornamented with irregular elevated ridges. The coronal integument is not so lofty.

Observations.—The specimens representing this species are much distorted and enlarged by silicification, but they show the essential characters of the species. The base of the small anal tube and the longitudinal nodes of the higher brachials are clearly shown.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee; Keokuk and Augusta, Iowa; Nauvoo, Illinois.

Cat. No. 39893, U.S.N.M.

Genus ALLOPROSALLOCRINUS Casseday and Lyon.

Conocrinites Troost, Proc. Amer. Ass. Adv. Sci., II, (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Alloprosallocrinus Casseday and Lyon, Proc. Amer. Acad. Arts and Sci., 1860, p. 29.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 353.—Meek and Worthen, Geol. Rep. Illinois, V, 1873, p. 368 (not Meek and Worthen, Proc. Acad. Nat. Sci. Phila., 1865, p. 164).—Zittel, Handb. d. Pal., I, 1879, p. 370.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 113.—Miller, North Amer. Geol. and Pal., 1889, p. 222.—Zittel, Text-Book Pal. (Eastman trans.), 1896, p. 143.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 406.—Bather, A Treatise on Zoology, III, The Echinoderma, 1900, p. 167.

Troost's description of this genus is as follows:

This crinoid though somewhat analogous to the genus *Agaricocrinites* by the arrangement of the plates which compose the body, differs nevertheless generically. The *Conocrinites* [*Alloprosallocrinus*] has no oral [anal] aperture like the *Agaricocrinites*, and is provided with a long proboscis which in one of my specimens is 2½ times larger [longer] than the diameter of the body. Moreover the column is not placed in the bottom of a profound basin, but in the centre of a horizontal plane. These characters separate it from the *Agaricocrinites*, and as the appearance of the whole if we take the body for a base, is that of a cone, I have given to it the name of *Conocrinites*.

GENERIC CHARACTERS.

Pelvis [base] hexagonal, divisible into three parts.
Costals, [radials] five, hexagonal.
Intercostals, [anal plate] one, sub-hexagonal, elongated.
Scapulars, [primaxils] five, pentagonal.
Arms, ten.
Inter scapulars [interbrachials and anal plates], seven, subhexagonal.

ALLOPROSALLOCRINUS TUBERCULOSUS (Troost).

Plate 5, figs. 14, 15.

Conocrinites tuberculosus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 229 (catalogue name).

Alloprosallocrinus conicus Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 353 (catalogue name).

The original description by Troost is as follows:

The hexagonal pelvis [base] is depressed towards the centre and bears a circular impression of the column. The articulating surfaces of the plates are striated and the alimentary canal [lumen] is circular. The five depressed hexagonal costals [radials] are placed upon five of the sides of the pelvis, and the elongated intercostal occupies the sixth side of it. [?] This intercostal [secondary anal plate] projects beyond the costals [radials]. Between the costals [radials] and scapulars [primaxils] are small plates which penetrate partly the superior edge of the costals [radials] and the inferior edge of the scapulars [primaxils]. Of the five pentagonal scapulars [primaxils], three

support two arms while the two between which the elongated intercostal [anal] terminates, support three arms. Of the seven interscapulars [interbrachials], five [four] are elongated sub-hexagonal and support upon the two oblique superior edges two small plates; two are broad and short—and the seventh, which is elongated and contracted projects beyond the other interscapulars [anals], between the three handed arms. The latter is placed immediately upon the elongated, intercostal, [first anal] and the five [four] elongated, together with the two broad interscapulars [interbrachials], are placed in the re-entering angles formed by the junction of the costals [radials].

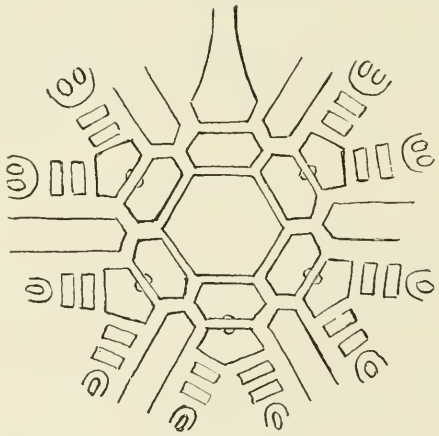
Upon three of the pentagonal scapulars [primaxils] are placed two arms while those which are next to the elongated and the two broad interscapulars [interbrachials] have three arms.

The whole of this construction forms an irregular pentagonal or star-shaped plane, supported by a cylindrical column attached to its centre, and is covered by a pyramidal or conical coronal integument, composed of tumous polygonal plates, which terminates in a long proboscis.

I can say nothing respecting the hands and their subdivision. All my specimens in this respect are defective.

Judging from a specimen in my collection where a fine body is placed on a fragment of the rock in which it occurs and is surrounded by columnar joints, its column was composed of joints with radiating articulating surfaces having a circular or pentagonal alimentary canal [lumen].

I discovered it near White's Creek Springs, Davidson County, Tennessee.



TROOST'S DIAGRAM SHOWING ARRANGEMENT OF PLATES OF A. TUBERCULOSUS.

Observations.—The specimen representing this species is missing, and in the absence of further information Doctor Troost's description and figures are reproduced as they stand. The species is referred to *Alloprosallocrinus*, as it appears to be related to that genus in the form of the body and arrangement of the plates, so far as it can be determined.

There is a discrepancy between the description and the figures in representing the position of the first anal plate. The figures show an hexagonal first anal followed by three elongate plates, while the description places the central elongate plate between the radials.

The figures are more likely to be correct as the first anal usually corresponds more or less in size and shape with the radials.

Alloprosallocrinus tuberculosus resembles in many respects *A. celsus* Miller and Gurley, but important differences appear in the descriptions of the two species, and in the absence of Doctor Troost's type it can not be referred to *A. celsus*. The first primibrachs are well-developed plates in *A. celsus*, minute in *A. tuberculosus*, the interbrachials are two short plates in line instead of one long one, and the second anal plate in *A. celsus* is short and followed by two short plates. The tubercles on the dorsal cup of the latter are extremely prominent while they are not described for *A. tuberculosus*, but the name indicates that tubercles of some kind are present.

ALLOPROSALLOCRINUS CONICUS Casseday and Lyon.

Conocrinites lex Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 229 (catalogue name).

Alloprosallocrinus conicus Casseday and Lyon, Proc. Amer. Acad. Arts and Sci., V, 1860, p. 29.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 114 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 222 (catalogue name).—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 407, pl. xlii, figs. 14 *a*, *b*, *c*.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 75 (catalogue name).

Actinocrinus (*Alloprosallocrinus*) *conicus* Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 353 (catalogue name).

Alloprosallocrinus gurleyi Miller, 17th Rep. Geol. Surv. Indiana (Adv. sheets 1891, p. 58, pl. x, figs. 1, 2), 1892, p. 668, pl. x, figs. 1, 2.

The description by Troost is as follows:

It is distinguished from *C. tuberculosus* by being more circular, and by its coronal integument being composed of polygonal plates which are slightly convex and almost smooth, and by its proboscis not being so stout. These differences are not produced by age—I have juvenile specimens of both species.

It occurs at White's Creek Springs.

Observations.—Two specimens in the Troost collection correspond closely with the figures and description of *Alloprosallocrinus conicus* Casseday and Lyon. In two of the rays, small first primibrachs are differentiated, but this does not hold true of the other rays.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Davidson County, Tennessee; Pilot Knob, near Louisville, Kentucky; New Ross, Montgomery County, Indiana.

Cat. No. 39923, U.S.N.M.

Genus DIZYGOCRINUS Wachsmuth and Springer.

DIZYGOCRINUS SACCULUS (Miller and Gurley).

Plate 5, figs. 1, 2, 3, 4, 5, 6.

Actinocrinites fibula TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Actinocrinus fibula SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 344 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 224 (catalogue name).

Batocrinus sacculus MILLER and GURLEY, Bull. No. 5, Illinois State Mus. Nat. Hist., 1894, p. 52, pl. v, figs. 7, 8, 9.—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 133 (catalogue name).

The following description is by Troost:

This species differs much in its general appearance from the generality of the *Actinocrinites*, and though the number and arrangement of the plates, which are somewhat obscure in my specimens, seem to be identical with those of the genus *Actinocrinites*, it is nevertheless with hesitation that I place it in this genus.

The whole body has the form of a flat circular dish, slightly elevated at the rim and more or less depressed toward the centre. In the very centre is an elevated ring which seems to have been the first joint of the column having a circular alimentary canal [lumen]. It has twenty [eighteen] horseshoe form apertures for fingers [arms] on the margin of the elevated rim, and a low coronal integument composed of polygonal tumous plates, terminating at the apex in a proboscis so that in this species the viscera were not inclosed in the cavity of a cup but they lay upon an almost flat dish and were covered by a low conical coronal integument.

They occur near White's Creek Springs. They are rather rare. I found only two specimens—having the form of a button has induced me to give it the name of *fibula*.

I consider the fossil represented by figs. [4, 5, 6] as an internal cast of the *A. fibula*. Breaking a siliceous rock of the Devonian strata, I found it uninjured in a small cavity which has the intaglio form of the fossil. The joints of the plates are at some parts very plain. Below each plate is a depression in which are, from two to four longitudinal apertures. The pelvis [base] is hexagonal and supports two series of hexagonal costals [radials] upon which follows a pentagonal scapular, [primaxil] the joints of the intermediate plates are not plain—the rim is surrounded by ten [nine] pair of fingers [arms]. The superior part is compressed hemispherical. From each pair of fingers proceeds a vessel (in bas-relief). These vessels, casts of ambulacra, after ascending a short distance join two and two forming then five large vessels which near the apex join all together and probably communicated in the proboscis—if such organ existed—I see no traces of it on the cast,—but if it really is a cast of the *A. fibula*, a proboscis must have existed. A little below the apex just in the angle formed by the junction of two of the five vessels is an elevation which indicates an aperture in the cover,—or may have opened into the proboscis as no trace of an aperture is perceptible near the proboscis in the perfect specimens.

This was discovered in Stewart County, Tennessee.

Observations.—Four specimens in the Troost collection agree with *Dizygocrinus sacculus* (Miller and Gurley) except in the more depressed calyx, but the height of the calyx varies in the four specimens at hand and the low cup is, in part at least, due to compression during fossilization.

These specimens agree in general form with *D. decoris* Miller, but differ in the entire absence of the strong angular ridges which, in the latter species, cross the radial series of plates from the basals to the

arm bases. Their form also agrees closely with that of *D. euconus* var. *abscissus* Rowley and Hare, but that species has thirty-two arms while *D. sacculus* has but eighteen.

The mold of the interior figured on plate 5, figs. 4–6, is interesting as showing casts of the ambulacra and arm openings in relief. The arrangement of the calyx plates is shown more distinctly by the mold than by some of the actual calyces. The depressions on the mold, mentioned by Doctor Troost, seem to indicate that the interior of each plate was convex and bore at its center two or more very slender, laterally compressed spines.

Batocrinus sacculus Miller has been referred to *Dizygocrinus* since it possesses the characteristic features of that genus in the low dorsal cup, high tegmen, short basals with projecting circular rim, slender anal tube, etc.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Davidson County, and Stewart County, Tennessee; Washington County, Indiana.

Cat. Nos. 39897, 39898, U.S.N.M.

DIZYGOCRINUS UNIONENSIS (Worthen).

Actinocrinites mortonii (in part) Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).

Actinocrinus mortoni Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 346 (catalogue name).—Wachsmuth and Springer, Rev. Paleocrinoidea, II, 1881, p. 225 (catalogue name).

Batocrinus unionensis Worthen, Bull. No. 2, Illinois State Museum Nat. Hist., 1884, p. 26.—Miller, North Amer. Geol. and Pal., 1889, p. 228 (catalogue name).—Worthen, Geol. Rep. Illinois, VIII, 1890, p. 84, pl. xii, figs. 5, 5*a*; pl. xiii, fig. 3.

Batocrinus pulchellus Miller, Adv. Sheets 17th Geol. Rep. Indiana, 1891, p. 68, pl. xi, figs. 13, 14.

Batocrinus davisi Rowley and Hare, Kansas City Scientist, 1891, p. 116, pl. iii, fig. 9.

Dizygocrinus unionensis Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 424, pl. xxxv, figs. 16, 17, 18, 19, 20.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 235 (catalogue name).

Observations.—Of the two specimens in the Troost collection labeled *Actinocrinites mortonii* one is evidently *Dizygocrinus unionensis* (Worthen), while the other represents the variety *divalis* (Miller). Doctor Troost's description and figure evidently apply to the latter and are reproduced under that name. The variety differs from the species in being larger and in having the arms double from their point of origin.

Full descriptions with figures of the species have been given by Worthen [1884 and 1890] and Wachsmuth and Springer [1897].

Formation and locality.—Warsaw limestone. Huntsville, Alabama; Tateville, Pulaski County, Kentucky; Boonville, Missouri; Lee County, Virginia.

Cat. No. 39985, U.S.N.M.

DIZYGOCRINUS UNIONENSIS DIVALIS (Miller).

Plate 5, fig. 16.

Actinocrinites mortonii (in part) TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Batocrinus divalis MILLER, 18th Rep. Indiana, Dep. Geol. and Nat. Res. (Adv. sheets, 1892, p. 22, pl. III, figs. 6, 7), 1894, p. 276, pl. III, figs. 6, 7.

Dizygocrinus unionensis var. *divalis* WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, 1897, p. 425, pl. XXXV, figs. 21, 22, 23, 24.—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 235 (catalogue name).

The following description is by Troost:

A shallow dish shaped cup, composed of small, broad, tumous plates, arranged as in the genus *Actinocrinites*, but in the *A. mortonii*, the cup continues for four plates beyond the arm joints, and the division of hands and fingers takes place before the rim or superior margin of the cup is completed.

In general the cup of the *Actinocrinites* terminates with the series of the plates formed by the arms, as is mentioned by Miller[a] (page 99). "We have thus the figure of a cup completely formed, of which the arm joints adhering to the scapula, and several multangular pieces (called by me pectoral plates) belonging to the plated integument form the rim."—In this respect the *A. mortonii* differs from the genus *Actinocrinites;*—all the divisions of arms till it arrives at 30 tentaculated fingers, take place on the cup, and the last division which gives rise to the 30 [thirty-six] fingers, forms the superior edge or rim of the cup. Then no ulterior division takes place, so that the whole superstructure of the crinoid is formed of 30 feathered or tentaculated fingers.

I found only fragments of it in the State of Tennessee. It seems to be more abundant in the north of Alabama. I possess a perfect specimen found in the Carboniferous strata in the vicinity of Huntsville.

I have dedicated this species to my friend Dr. S. G. Morton of Philadelphia, author of the Crania Americana and of several geological memoirs.

Observations.—S. A. Miller [1892] described this form as a distinct species, but its relationship with *Dizygocrinus unionensis* is so close that it is evidently not more than a variety of that species as stated by Wachsmuth and Springer [1897].

Formation and locality.—Warsaw limestone. Boonville, Missouri; Huntsville, Alabama.

Cat. No. 39902, U.S.N.M.

Genus LOBOCRINUS Wachsmuth and Springer.

Lobocrinus WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, 1897, p. 434.

Observations.—Two of the species now included in this genus were for a time separated from *Actinocrinus* under the name of *Uperocrinus* as a subgenus of *Batocrinus*. *Uperocrinus* was first proposed by Meek and Worthen [1865] for forms "having the body below the arms very narrow, and drawn out so as to form a kind of handle to the upper part." In the group were included *Actinocrinus pyriformis* Shumard, *A. pistillus* Meek and Worthen, and *A. pistilliformis* Meek and Worthen. Later, in the Geological Survey of Illinois, V, pp.

[a] Miller, J. S. A Natural History of the Crinoidea, 1821.—E. W.

365, 367, the name *Uperocrinus* was abandoned by these authors and the species formerly included under it referred to *Batocrinus* as group A, which is characterized by having the arm openings directed outward instead of upward. Another group, B, is described as having the arm openings directed upward, and to this group *Actinocrinus nashvillæ* (Troost) Hall is assigned. Bather [1900, p. 168] revived Meek and Worthen's name *Uperocrinus*, changing it, however, to *Hyperocrinus*, and gave *Lobocrinus* as a synonym of it, but as the earlier name was abandoned by its authors it seems that *Lobocrinus* should hold. *Lobocrinus* is, moreover, used in a somewhat different sense from that of *Uperocrinus*.

LOBOCRINUS NASHVILLÆ (Hall).

Plate 6, figs. 1, 2, 3, 4.

Actinocrinites nashvillæ TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Actinocrinus nashvillæ HALL, Geol. Surv. Iowa, I, Pt. 2, p. 609, pl. XV, fig. 4, pl. XVI, figs. 4*a*, *b*.—SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 346 (catalogue name).—QUENSTEDT, Handb. d. Petrefactenkunde, 1885, pl. LXXVII, fig. 2.

Batocrinus nashvillæ WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 167 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 228 (catalogue name).—WORTHEN, Geol. Surv. Illinois, VIII, 1890, p. 85, pl. XIII, fig. 5.—KEYES, Missouri Geol. Surv., IV, 1894, p. 183.

Lobocrinus nashvillæ WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, 1897, p. 435, pl. XXXI, fig. 1.—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 332 (catalogue name).

The following description is by Troost:

It has the form of a vase like the *A. urna* [*Batocrinus grandis*] but differs from it in having a broader base and the cup extending more regularly towards its superior rim, the apertures for the insertion of the fingers [arms] lying on the level of the coronal integument, so that by taking a top view of the body we see the 20 apertures, which are invisible when a lateral view is taken. Also the coronal integument rises more abruptly and the proboscis is much wider. This proboscis distinguishes it eminently from the *A. urna* which has a slender proboscis,—in this species it is very capacious, it is composed of four longitudinal ranges of polygonal plates which are pointed. The plates of the cup are not much elevated, some are almost smooth, those of the coronal integument on the contrary are much elevated in the centre, almost pointed.

Observations.—The first published description of this species was by James Hall, although, on account of Hall's reference to Troost's manuscript description then in his possession, the species is usually accredited to Troost, who wrote the first description of it. It has since been several times described, by Worthen [1890], Wachsmuth and Springer [1897], etc.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Davidson County, Tennessee; Button Mould Knob, Kentucky; Keokuk, Iowa; Warsaw and Nauvoo, Illinois.

Cat. No. 39894, U.S.N.M.

LOBOCRINUS ROBUSTUS Wachsmuth and Springer.

Actinocrinites holbrooki Troost, MSS., 1850.

Lobocrinus robustus Wachsmuth and Springer, North American Crinoidea Camerata, 1897, p. 436, pl. xxx, figs. 8*a*, *b*.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 333.

The following description is by Troost:

This crinoid has the form of two cones joined base to base, from the junction of which project five large arms, which convert the circular rim of the cones into a pentagon and give it the appearance, when a top or bottom view is taken, of a star with obtuse rays. The plates covering the cup are smooth and more or less elevated in the centre. Those that cover the capital integument are tumid, projecting almost hemispherically above the surface. The capital integument (the superior cone) is more elevated and larger than the inferior one and terminates in a large proboscis, the superior extremity of which is wanting in my specimen.

Decatur County, Tennessee, Silurian.

Observations.—This species is represented in the Troost collection by a single young individual, which is fairly well preserved.

Formation and locality.—Keokuk horizon of Tullahoma formation. White's Creek Springs, Decatur County, Tennessee.

Cat. No. 39901, U.S.N.M.

Family PERIECHOCRINIDÆ Bather.

Genus PERIECHOCRINUS Austin.

PERIECHOCRINUS TENNESSEENSIS (Hall).

Plate 6, fig. 10.

Crumenæcrinites ovalis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850.

Actinocrinites tennesseeæ (in part), Troost, MSS., 1850.

Saccocrinus tennesseensis Hall, Geol. Rep. Ohio, Pal., II, 1875, p. 125, pl. vi, fig. 10.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 236 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 279 (catalogue name).

Periechocrinus tennesseensis Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 528.

The following description of *Actinocrinites tennesseeæ* is by Troost:

Its external form is that of an elevated goblet with a low, dome-shaped capital integument.

It differs from the generality of *Actinocrinites* in the dimensions and form of the proboscis which in the true *Actinocrinites* diminishes gradually in diameter from its base to its summit, whereas in the *A. tennesseeæ* it is already of a small diameter when it rises above the integument.

The large figure is very imperfect as to the arrangement of its plates—the small figure [pl. 6, fig. 10] is a perfect representation.

Observations.—Hall's description of this species contains a reference to Troost's manuscript description, but according to the rules of priority the species should be accredited to Hall.

The following description of *Crumenæcrinites ovalis* is by Troost:

Body elongated ellipital terminating at its base in a solid point, showing no trace or cicatrice for the insertion of a column [?].

Pelvis [base]—divisible into three irregular pentagons; when joined together they form three re-entering angles and three straight edges the first, (re-entering angles) supporting three heptagonal costals [two radials and an anal] while the straight edges support three hexagonal costals [radials].

The places between the interscapulars [interbrachials] and arms are covered with an arrangement of small plates in the form of a rosette. All the plates, with the exception of those of the pelvis, [base] are ornamented with slight elevated ridges radiating from the center of the plates and disappearing before they reach the margin.

This fossil is mostly imbedded in limestone (an aggregate of water worn small fragments of fossils) showing the whole of the pelvis and more than half of the body and hands.

I discovered it in Decatur County, Tennessee. It is the only one that I have seen.

Observations.—The genus *Crumenæcrinites* was founded on a specimen which was believed to be without a column, but it is undoubtedly a *Periechocrinus* from which a part of the base has been broken away. It is apparently identical with *P. tennesseensis.*

The specimen shows ridges traversing the radial series, as is usual for the species, and two of the radials have traces of transverse ridges, but I am unable to distinguish ridges radiating from the centers of all the plates, as described by Troost.

Formation and locality.—Brownsport limestone. Perry and Decatur counties, Tennessee.

Cat. Nos. 39915, 39916, U.S.N.M.

PERIECHOCRINUS DUBIUS (Troost), new name.

Actinocrinites tennesseeæ (in part) TROOST, MSS., 1850.

Gilbertsocrinites (?) *dubius*, TROOST, MSS., 1850.

Saccocrinus speciosus ROEMER, Die Sil. Fauna d. west. Tennessee, 1860, p. 42, pl. III, figs. 3*a*, *b*, *c*.—SHUMARD (in part), Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 395 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 279 (catalogue name).

Periechocrinus speciosus (in part) WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 133 (catalogue name); North Amer. Crinoidea Camerata, 1897, p. 521.

The following description of *Gilbertsocrinites* (?) *dubius* is by Troost:

It has a funnel shaped form; it is more or less angular and somewhat bent at its base. My most perfect specimen is siliceous and no joints of plates are perceptible. From a mutilated specimen it appears, that it is composed of a pentagonal pelvis [base], having five reentering angles in which are placed five heptagonal first costals [radials] which support five hexagonal second costals [first primibrachs] between which are placed five pentagonal inter costals [interbrachials]. Then follow a number of polygonal plates, the arrangement of which its mutilated state prevented me from ascertaining.

Around its superior rim are five arms divided into ten hands. Five elevated ridges ascend from the base and bifurcate before reaching the superior rim, and gives it the angular appearance mentioned above.

The place for the insertion of the column is small, circular, and perforated by a stellate alimentary canal.[a]

Decatur County, Tennessee.

Observations.—There are in the Troost collection two species of *Periechocrinus*. One is *Periechocrinus tennesseensis* as described by Hall with twenty arms, the other is *P.* (*Saccocrinus*) *speciosus* Roemer (not Hall) which differs from *P. tennesseensis* in having three arms on each side of the anal area or twenty-two in all. Wachsmuth and Springer say in reference to the latter, "We have in our collection several specimens from that locality with four arms to each ray, but none with three in the posterior rays, as shown in Roemer's figure, which is said to be a restoration." They discredit Roemer's figure and unite his species with *P. tennesseensis* because their collection furnished no specimens showing the three arms on each side of the posterior area, but there are five specimens in the Troost collection that show this feature distinctly. Roemer fully described his specimen but referred it to *P. speciosus* Hall from which it differs widely in the number of arms. This specimen differs from those of Troost in having only two arms in the anterior and left antero-lateral ray, but the four arms in the right antero-lateral ray and the tertaxil plate in the posterior half of the left antero-lateral ray indicate that the plan of the specimen is the same as those of the Troost collection, and the differences are probably abnormalities.

Roemer's species is, therefore, a valid one but requires a new name. I propose for it the name given by Troost to two of his specimens. The name *dubius* was given to two imperfect specimens which evidently belong to the genus *Periechocrinus*, and they have apparently three arms on each side of the anal area although Troost's description mentions only two arms to each ray. The specimens are so poorly preserved that their identification is somewhat doubtful, but they seem to belong with Roemer's species. The well preserved specimens of this species were placed by Troost with his *Actinocrinites tennesseeæ*, a description of which was published by Hall, as noted above. It appears, therefore, that both species occur at this locality.

Formation and locality.—Brownsport limestone. Perry and Decatur counties, Tennessee.

Cat. Nos. 39967, 39982, U.S.N.M.

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[a] As is mentioned above, my most perfect specimen only exhibited its form and elevated ridges, I was obliged to take the other characters from a mutilated specimen in which the arrangement of the plates was visible, nevertheless it is with hesitation that I place it in the genus *Gilbertsocrinites*.—Troost.

PERIECHOCRINUS (?), species undetermined.

Plate 6, figs. 6, 7.

Actinocrinus moniliformis J. S. MILLER, Nat. Hist. Crinoidea, 1821, p. 115.—PHILLIPS in Murchison's Sil. Syst., 1839, p. 673, pl. XVIII, fig. 4.

Actinocrinites moniliformis (?) TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*).

Periechocrinus moniliformis WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, pp. 128, 132.

The original description by Troost is as follows:

The superior part. The fingers—forty in number.

Our fossil resembles the superior part, the fingers of the figure given by Phillips of the *Actinocrinites moniliformis* (Murches. Sil. Sys. pl. 18, fig. 4). This species was conjectured by Miller and described by Phillips. It is only a conjecture of mine whether the Tennessee fossil really belongs to this species. It can not be decided, as the whole of the cup is wanting. If we take the number of fingers only into consideration, then it may also belong to the *A. polydactilus* of Miller, which according to this author may have 30 or 40 fingers. According to Phillips the *A. moniliformis* has 40 fingers and our specimen also has 40 fingers. A circumstance mentioned by Miller on the authority of Lhwyd is the extraordinary length of the proboscis of the *A. polydactilus*, which would favour placing it in the species of the *A. polydactilus*. In our specimen the proboscis may be seen in fig. [7] and about 1½ inch above it where the specimen is injured, the proboscis continues,—in fact I have fragments of probosces which are 3 inches long and which I consider as belonging to similar crinoids as our specimen. It is therefore undecided whether our fossil belongs to *A. moniliformis*, *A. polydactilus*, or whether to a new genus. I have nevertheless thought proper to rank it provisionally as *A. moniliformis*, because it resembles more the fingers as they are represented by Phillips than those that are represented by Miller of the *A. polydactilus*.

The same specimen contains a fragment of a column which is composed of joints with rounded sides, but not alternating small and large; it is perforated by a large pentalobed alimentary canal [lumen], striated near the margin and is 14 mil. m. in diameter, consequently if this column belonged to this crinoid, it must have been of a gigantic size.

I found it on the banks of the Cumberland river near Clarksville in limestone of the same geological age as that in the vicinity of Nashville (Silurian) [?].

Observations.—It is impossible to say to what species or even to what genus these arms belong. Doctor Troost has referred them to *Periechocrinus moniliformis* (Miller), since they resemble the arms of that species in number and general appearance, but it seems probable that if really of the genus *Periechocrinus* they belong to species occurring in Tennessee. In the absence of satisfactory data they can not be referred to any one of these.

Formation and locality.—Brownsport limestone? Near Clarksville, Montgomery County, Tennessee.

The formation upon which the town of Clarksville rests is the Upper Lithostrotion bed of Safford, correlated by him with the St. Louis limestone, but Doctor Troost's label refers the specimen to strata of the age of that near Nashville, that is, Brownsport lime-

stone. As the specimen was found on the banks of the Cumberland River this may be the correct horizon.

Cat. No. 39903, U.S.N.M.

Suborder ACTINOCRINOIDEA Bather.

Family ACTINOCRINIDÆ Bather.

Genus ACTINOCRINUS Miller.

ACTINOCRINUS MAGNIFICUS Wachsmuth and Springer.

Plate 1, fig. 1.

Actinocrinites humboldti Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Actinocrinus humboldti Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 344 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 225 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 218 (catalogue name).

Actinocrinus magnificus Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 567, pl. liii, fig. 2.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 60 (catalogue name).

The following description is by Troost:

This crinoid was probably the most magnificent species that ever has existed. Its gigantic size, its elegant form, the beauty and regularity of the ridges which ornamented its surface,—and, if we supply in imagination the parts that are wanting to complete the whole cup, with its coronal integument and high proboscis, and then add its lofty structure of hands and graceful tentaculated fingers—we form a structure equal—I had almost said—to the most charming object in nature. It is no wonder that such a body composed of plates and joints that were only kept together by cartilage, is now so much mutilated; in fact with diligent search, repeated several times, I found only fragments, and nothing could enable me to complete it beyond the part represented in the figure,[a] which is an exact representation of what is in my collection, except that the original specimen is more or less crushed, which is remedied in drawings. From the moment I became acquainted with it, I dedicated this splendid species to Baron von Humboldt in whose company I had often the honor to spend some of my time when in Paris.

I presume the proboscis and the whole superstructure was very large; I have a proboscis attached to a coronal integument which is very elevated in the centre, and composed of polygonal tumous plates. This proboscis which is smooth, is about 5 cent. met. long and yet the upper part is broken off—very probably it belonged not to this species, but to a smaller individual, the coronal cover being too minute for the specimen here represented.

Discovered near White's Creek Springs, Davidson County, Tennessee.

Observations.—This fine species is fully described by Wachsmuth and Springer. The plates of the Tennessee specimens are larger than those from Indiana, but appear to be otherwise similar.

Troost's figure is largely a restoration. The calyx plates are sufficiently preserved to show their number and arrangement as represented, but the arms are not preserved.

[a] Doctor Troost's manuscript contained a figure exactly like that of fig. 1, pl. 1, and drawn from the same specimen, omitting the arms which are not preserved but are restored in the drawing of fig. 1.—E. W.

Formation and locality.—Keokuk horizon of the Tullahoma formation. Indian Creek, Montgomery County, Indiana, White's Creek Springs, Davidson County, Tennessee.

Cat. No. 39900, U.S.N.M.

ACTINOCRINUS PERNODOSUS Hall.

Actinocrinus pernodosus HALL, Geol. Rep. Iowa, I, Pt. 2, 1858, p. 608, pl. XV, figs. 3*a*, *b*; pl. XVI, fig. 7.—SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 346 (catalogue name).—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, II, 1881, p. 145 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 219 (catalogue name).—KEYES, Missouri Geol. Surv., IV, 1894, p. 190.—WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, 1897, p. 561, pl. LV, figs. 2*a*, *b*.—WELLER, Bull. No. 153, U. S. Geol. Surv., p. 61 (catalogue name).

Among some miscellaneous fragments in the Troost collection is a specimen which apparently represents the lower part of the calyx of this species.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee(?). The specimen in Doctor Troost's collection bore no locality label, but as it is preserved in the same manner as his material from White's Creek Springs it is probably from that locality. Keokuk, Iowa; Nauvoo, Hamilton, and Warsaw, Illinois; Wayland, Clark County, Missouri.

Cat. No. 39977, U.S.N.M.

Subclass DICYCLICA Bather.

Order DICYCLICA INADUNATA Bather.

Suborder CYATHOCRINOIDEA Bather.

Family CYATHOCRINIDÆ Bather.

Genus CYATHOCRINUS Miller.

CYATHOCRINUS BRITTSI Miller and Gurley.

Plate 15, figs. 2, 3.

Cyathocrinites tennesseæ TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850 (*nomen nudum*); MSS., 1850.

Cyathocrinus tennesseeus WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, I, 1879, p. 149 (catalogue name).

Cyathocrinus tennesseæ MILLER, North Amer. Geol. and Pal., 1889, p. 237 (catalogue name).

Cyathocrinus brittsi MILLER and GURLEY, Bull. No. 7, Illinois State Mus. Nat. Hist., 1895, p. 70, pl. IV, figs. 35, 36.

The following description is by Troost:

This crinoid was at first mistaken for a species of *Siderocrinites* Troost with which it has some resemblance, but it differs from it by having only a single quadrilateral interscapular whereas the *Siderocrinites* has five intercostals.

It is basin-shape.—Its horizontally projecting scapulars [radials] give to its superior part a pentagonal form. Its subpentagonal costals [basals] are so short that they appear almost triangular. Its pelvis [base composed of five infrabasals] is small being almost entirely taken up by the circular cicatrice of the column.

It occurs in Decatur County, Tennessee.

Observations.—The figures of Miller and Gurley correspond with Doctor Troost's specimen so closely that except for a slight difference in size they might have been drawn from it.

Formation and locality.—Brownsport limestone (?) Decatur County, Tennessee; Burlington (?), Sedalia, Missouri.

The crinoids collected by Troost in Decatur County are from the Brownsport limestone, while this species is recorded by Miller and Gurley from the Burlington. Notwithstanding the great discrepancy in horizon these fossils are too closely similar to be considered distinct species, yet it is unlikely that a species would persist unchanged from the Brownsport to the Burlington. There is probably an error in the labelling of one or other of the specimens. The manner of preservation of Troost's fossil is precisely like that of other specimens from the Brownsport limestone of Decatur County, which would favor Doctor Troost's label as being the correct one; but the point could best be settled by finding other specimens of the species at either locality.

Cat. No. 39948, U.S.N.M.

CYATHOCRINUS GLOBOSUS Troost.

Plate 5, figs. 17, 18.

Cyathrocrinites globosus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Cyathocrinus globosus Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 148 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 235.

The original description by Troost is as follows:

This and the following species, *Zeacrinus depressus*, are in the same category with the *C. crateriformis* [*Eupachycrinus boydi*]. It differs from the preceding in being more elevated, the costals [basals] being in proportion much larger. The pelvis [base] does not penetrate into the body but is level with the surface of the cup—and the angles of the pelvis [infrabasal plates] being more acute and running partly between the costals [basals] gives it the form of a star, which is perforated by a pentagonal aperture.

It occurs in Decatur County, Tennessee.

Observations.—The specimen representing this species is missing and Troost's description and figures are published without change.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

CYATHOCRINUS (?) MUNICIPALIS (Troost).

Plate 11, fig. 5.

Poteriocrinites municipalis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Poteriocrinus municipalis Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 392 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 152 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 274 (catalogue name).

The original description by Troost is as follows:

It differs only from the *Poteriocrinites nobilis*, represented in Phillips (Geol. of Yorkshire Pt. 2, pl. 3, fig. 40) in the subdivision of the fingers.

Observations.—This species is referred with much doubt to the genus *Cyathocrinus*. The radials are now separated, but whether this separation is due to compression or whether interbrachials were formerly present can not be determined from the specimen.

The specimen may be compared with species of *Botryocrinus* in the form of the dorsal cup and the arrangement of the plates on the anterior side. The posterior side is imbedded in the matrix, hence it is impossible to determine the presence or absence of a radianal.

The arms show no trace of the stronger rami characteristic of *Botryocrinus*, but instead the lateral bifurcations are equal in size with a greater number of brachials in "the admedian branch of the dichotom," as described by Bather for the genus *Cyathocrinus*. The species is referred to *Cyathocrinus* more from the character of the arms than from the calyx, which is too poorly preserved to define the position of the species.

Formation and locality.—St. Louis limestone, Lawrence County, Tennessee.

Cat. No. 39937, U.S.N.M.

Suborder DENDROCRINOIDEA Bather.

Family DENDROCRINIDÆ Bather.

Genus DENDROCRINUS Hall.

DENDROCRINUS POLYDACTYLUS (Shumard).

Homocrinus polydactylus SHUMARD, Trans. Acad. Sci. St. Louis, I, 1857, p. 78, pl. 1, fig. 6; II, No. 2, 1866, p. 378 (catalogue name).

Cyathocrinites conglobatus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Dendrocrinus polydactylus MEEK, Geol. Surv. Ohio, Pal., I, 1873, p. 22, pl. III, *bis.*, fig. 9.—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, I, 1879, p. 77 (catalogue name).—MILLER, North Amer. Geol. and Pal., p. 239 (catalogue name).

The description by Troost is as follows:

Pelvis unknown—It is small, inserted in a deep cavity, supported by a cylindrical column. Costals [infrabasals] composed of almost spherical plates, laterally compressed—the superior part cuneiform. Scapulars [basals] placed in the re-entering angles of the costal series [infrabasals], are very tumous, their superior margin is cuneiform supporting two bifurcated arms.

It is spread out over limestone entirely composed of *Orthis* [*Dalmanella*] *testudinaria*, *Leptena* [*Rafinesquina*] *alternata* and others.

Occurs in the vicinity of Nashville, Davidson County, Tennessee, and in the State of Ohio.

Observations.—The radials of this species are somewhat crushed and displaced, and Doctor Troost has evidently mistaken the basals for radials, assuming the existence of a circle of minute plates below the true infrabasals. The latter are large and tumid plates.

Formation and locality.—Richmond group. The exact locality of this specimen is not known, but precisely similar specimens are found in the Richmond formation of Ohio and Indiana.

Cat. No. 39950, U.S.N.M.

Family BOTRYOCRINIDÆ.

Genus BARYCRINUS Wachsmuth.

BARYCRINUS STELLATUS (Hall).

Plate 8, figs. 6, 7, 8.

Cyathocrinites stellatus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850 (*nomen nudum*); MSS., 1850.

Cyathocrinus stellatus Hall, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 623, pl. xvi, figs. 3, 8.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 364 (catalogue name).

Cyathocrinus quinquelobus Meek and Worthen, Proc. Acad. Nat. Sci. Phila., 1865, p. 150; Geol. Surv. Illinois, III, 1868, p. 519, pl. xx, fig. 6*a*, *b*.

Barycrinus stellatus Wachsmuth and Springer Rev. Paleocrinoidea, I, 1879, p. 103 (catalogue name).—Keyes, Missouri Geol. Surv., IV, 1894, p. 210.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 122 (catalogue name).

The original description by Troost is as follows:

The cup is basin-shape. The pelvis, near the base, is beautifully carved with a figure composed of a double undulated circle twisted in such a manner as to give it the resemblance of a rose, in the centre of which the column is inserted. The five sides of this pelvis [infrabasals] support five tumid almost acute conical costals [basals] giving it the form of a star—this star forms the base of the cup. In the re-entering angles of it are placed five subpentagonal tumid scapulars [radials] and one interscapular [anal plate]. The scapulars [radials] have a broad sloping superior surface which supports the arms. It occurs in Stewart County, Tennessee.

Observations.—Hall's specimen, which must now serve as the type of the species, is not so well preserved as that of Troost, and the latter should have been used as the type, since it is the specimen first described under the name of *stellatus*.

Formation and locality.—Keokuk horizon of the Tullahoma formation. Stewart County, Tennessee; Warsaw, Illinois; Boonville, Curryville, Pike County, Missouri.

Cat. No. 39942, U.S.N.M.

BARYCRINUS PENTASPHERICUS (Troost).

Plate 5, figs. 7, 8.

Cyathocrinites pentasphericus Troost, MSS., 1850.

The original description by Troost is as follows:

It is a basin-shaped, transversely pentagonal cup. Pelvis [infrabasal plates]—nearly entirely taken up by the circular impression of the column. The costals [basals] have a pentagonal contour, but exhibit externally five hemispherical projections between which are placed five hemispherical scapulars [radials], truncated in such manner as to show five circular planes, having a furrow running inwardly from its [each] superior margin; upon this circular plane were attached five arms.

It occurs in a siliceous stratum one mile from Woodbury on the road to MacMinnville, Warren County, Tennessee. Devonian—was discovered by Prof. James M. Safford of Lebanon.

Observations.—Hall [1858, p. 625] has compared this species with his *Cyathocrinus tumidus*, from which it differs in the deeper, narrower cup and the larger column. The species differs from *Barycrinus subtumidus* Meek and Worthen in its small size and in having the basals smaller than the radials instead of larger, as in the latter species. The arm facets are also proportionally larger and are nearly vertical in position.

Barycrinus pentasphericus bears a close superficial resemblance to *Barycrinus geometricus* Meek and Worthen, but that species is said to lack the anal plate which is well developed in *B. pentasphericus*. The column is also proportionally smaller in the former species.

Formation and locality.—Keokuk horizon of the Tullahoma formation. Locality as given above.

Cat. No. 39947, U.S.N.M.

BARYCRINUS HOVEYI (Hall).

Cyathocrinites corrugatus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Cyathocrinus hoveyi Hall, Descr. New Species Crin., 1861, p. 5; Journ. Boston Soc. Nat. Hist., VII, 1861, p. 293.—Shumard, Trans. Acad. Sci. St. Louis, II, 1866, p. 362 (catalogue name).

Scaphiocrinus hoveyi Hall, Photo. Plates of Crinoids, 1872, pl. v, fig. 11.

Barycrinus hoveyi Meek and Worthen, Geol. Surv. Illinois, V, 1873, p. 486, pl. xiii, fig. 1.—Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 102 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 226 (catalogue name).—Keyes, Missouri Geol. Surv., IV, 1894, p. 209.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 120 (catalogue name).

Cyathocrinus corrugatus Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 148 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 235 (catalogue name).

The description by Troost is as follows:

It is coarsely wrinkled. The wrinkles proceed in high ridges from the pentagonal pelvis [infrabasal plates], they bifurcate on the costals [basals] and enter on both sides into the scapulars [radials] where they join with the ridge that proceeds from the opposite side, forming in this manner five subrhomboidal, elongated depressions on the surface of the body. The scapulars [radials] are deeply truncated for the reception of arms. The whole was surrounded by a granulated integument which is still partly attached to the body.

Observations.—Troost's specimen is a young individual of this species of which neither the arms nor column are preserved.

Formation and locality.—Keokuk horizon of the Tullahoma formation. Harpeth Ridge, Davidson County, Tennessee; Crawfordsville, Indiana; Boonville, Missouri; Keokuk, Iowa.

Cat. No. 39945, U.S.N.M.

BARYCRINUS EXPANSUS Miller and Gurley.

Barycrinus expansus Miller and Gurley, Bull. No. 5, Illinois State Mus. Nat. Hist., 1894, p. 41, pl. iv, fig. 2.—Weller, Bull. No. 153, U. S. Geol Surv., 1898, p. 119 (catalogue name).

An unlabeled specimen in the Troost collection is evidently of this species. It shows the upper part of the calyx and two arm bases only.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee.

Cat. No. 39978, U.S.N.M.

Family SCAPHIOCRINIDÆ Bather.

Genus SCAPHIOCRINUS Hall.

SCAPHIOCRINUS HUNTSVILLÆ Worthen.

Plate 6, fig. 11.

Cyathocrinites roemerii Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Scaphiocrinus huntsvillæ Worthen, Geol. Surv. Illinois, V, 1873, p. 534, pl. xx, fig. 1.—Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 113 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 280 (catalogue name).—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 544 (catalogue name).

Cyathocrinus roemeri Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 149 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 236 (catalogue name).

The following description is by Troost:

The characters of this delicate crinoid, for the greatest part imbedded in compact limestone, can not be easily ascertained, the joints of the plates being mostly obliterated when disengaged from its surrounding limestone. In fact those that I discovered in the State of Tennessee were too imperfect to show its construction, and I owe to the kindness of Dr. Newman, of Huntsville, Alabama, the one which has served for my description, even in this, the joints of the plates forming the cup are not very plain.

The cup is inverted conical, small and supported by a slender cylindrical column composed of alternating small and large joints with rounded margins. The five arm joints form the superior rim of the cup, from which proceed ten tentaculated hands, which after ascending six or seven [nine or ten] joints receives a cuneiform joint where they are subdivided into four tentaculated fingers.

Occurs in Maury County, Tennessee, near Duck River, and in the vicinity of Huntsville, Alabama, both Carboniferous limstone.

Observations.—The difference between Troost's specimen and that described by Worthen is chiefly one of size. The similarity in the arrangement of the calyx plates, so far as these are preserved, the mode of branching of the arms and the cuneiform arm plates have led to placing them in the same species.

The arms of Doctor Troost's specimen are broader near the base and the dorsal cup larger than shown in his figure.

Formation and locality.—St. Louis limestone. Near Huntsville, Alabama; Maury County, Tennessee.

Cat. No. 39944, U.S.N.M.

SCAPHIOCRINUS, species undetermined.

Plate 6, fig. 5.

Cyathocrinites planus (?) TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61; MSS., 1850.

The original description by Troost is as follows:

The body of this crinoid and its column resembles the *Cyathocrinites planus* of Miller, except that the scapulars have not the horse-shoe shape impression. It is impossible from the present state of our fossil to say whether there existed any difference in the construction of arms, hands, etc.

It is partly imbedded in an argillaceous sandstone which lies above the aluminous shale. This argilo-siliceous stratum has the appearance of chert or hornstone, at other places it resembles more or less tripoli, and is sometimes used as such. Large tracts of it pervade middle Tennessee in which no traces of organic remains can be found. Again we find spots where *Syringopora* and *Catenipora* occur, and at other places we find the rock entirely composed of several species of *Fenestella* amongst which are the *F. prisca* and *F. antiqua*. In this deposit also the rich iron ores (hydroxide of iron) of Middle Tennessee are situated. It is below the coal. M. Deverneuil considers it as Devonian.

Stewart County, Tennessee.

Observations.—This specimen is embedded in the matrix with the posterior interradius down, and only indistinct molds of the arm plates showing. The infrabasals are large, pentagonal; basals hexagonal, about equal in length and width; radials wider than long and truncated across their entire width for the reception of the arms. These characters indicate the genus *Scaphiocrinus*, but from the condition of preservation it is impossible to tell whether or not the specimen belongs to an already described species.

The arms are not as large or as simple as represented in Doctor Troost's figure, and the longitudinal ridges shown there are entirely wanting in the specimen. The arms are apparently about half the width of the radials, with strongly wedge-shaped plates, and they seem to branch once or twice above the radials. The column plates are circular, thin, and alternate in size.

The specimen bears some resemblance to *Poteriocrinus verus* Miller and Gurley, but the arm plates are shorter, the sides of the body more curved, and it is probable that the arms branch below the fifth or seventh plate above the radials.

Formation and locality.—Keokuk horizon of the Tullahoma formation. Stewart County, Tennessee.

Cat. No. 39949, U.S.N.M.

Family SCYTALOCRINIDÆ Bather.

Genus SCYTALOCRINUS Wachsmuth and Springer.

SCYTALOCRINUS (?) GRACILIS (Troost).

Plate 11, fig. 9.

Agassizocrinites gracilis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850.

Scaphiocrinus gracilis Hall, Rep. Geol. Surv., Iowa, I, Pt. 2, 1858, p. 551.

Agassizocrinus gracilis Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 352 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1886, p. 265 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 221 (catalogue name).

The description by Troost is as follows:

The general form of this crinoid is that of an inverted cone—composed of smooth plates.

Pelvis [infrabasals] five? triangular—superior margin more or less convex, so as to form, when joined together, a cup having five slightly reentering angles. No trace of the insertion of a column is visible at the base.

Costals [basals], five subpentagonal. They are placed in the slightly re-entering angles of the pelvis [base].

Scapulars [radials] five, subquadrilateral—they are placed in the reentering angles of the costals [basals] and support:—

Arms [primaxils]—five—they are more or less cylindrical, contracted in the middle and terminate in a cuneiform summit which supports two hands.

The capital integument seems to have been much elevated towards the centre, and was covered with polygonal plates. In my specimen the external surface is eroded and shows the joints of the plates of this capital integument from which it appears that they were surrounded by numerous spines intruding between those of the adjoining plates. This integument, as far as I can judge from my specimen, is larger than the whole body, from its base to its scapulars.

Occurs in the base of the Cumberland Mountains, Tenn., and in the vicinity of Huntsville, Alabama.

Observations.—This species was referred by Troost to the genus *Agassizocrinus* on account of the absence of a column, but it differs from *Agassizocrinus* in the smaller size of its infrabasals, in having basals smaller than radials, and radials truncated across their entire upper margin for the reception of the arms. The sutures between radials and primibrachs are gaping.

In these and in other features, except in the absence of a column, the specimen shows the characters of *Scytalocrinus* Wachsmuth and Springer. There is but one individual of the species in the collection, and the absence of a column in this case is believed to be accidental. The plates of the anal area and of the left postero-lateral ray are much distorted; hence it is probable that the crinoid lost its stem when young and lay on its side as it grew, producing the irregularity observed in the plates of that side. Four of the infrabasals meet in

a point at the center of the base, but the posterior infrabasal is smaller and does not quite reach the center.

If the discovery of other stemless individuals of this species should show the absence of a column to be a constant feature they would constitute a new genus, since they differ in the respects enumerated above from the stemless genus *Agassizocrinus*, but pending such discovery the single specimen at hand is placed with the genus *Scytalocrinus*, to which it is evidently closely related.

This species is distinguished from *S. decabrachiatus* Hall, its nearest ally, by the proportionally larger infrabasals, hexagonal instead of pentagonal basals, and by the strong median constriction of the primaxils.

The plates of the large central sac are well shown. The margins are cut into slender fringes by the elongate slit-like pores which cross the suture lines between them.

Formation and locality.—St. Louis limestone. Huntsville, Alabama.

Cat. No. 39917, U.S.N.M.

Genus ZEACRINUS Troost.

Zeacrinites Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Zeacrinus Hall, Geol. Surv. Iowa, I, Pt. 2, 1858, p. 544.—Meek and Worthen, Geol. Rep. Illinois, II, 1860, p. 186.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 398.—Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 125.—Miller, North Amer. Geol. and Pal., 1889, p. 288.—Zittel, Text-Book Pal. (Eastman trans.), 1896, p. 160.—Bather, A Treatise on Zoology, III, The Echinoderma, 1900, p. 180.

The original description by Troost is as follows:

If the number of plates that compose the body of an Encrinite determine its genus, then the one under consideration must perhaps be placed in that of the *Cyathocrinites*, but if the arrangement of these plates is also necessary to determine its genus then this crinoid can not belong to the *Cythocrinites* and forms a new genus, to which I have applied the name of *Zeacrinites*. [a]

Observations.—Doctor Troost's remarks, together with a detailed description and diagram of plates, were published by Hall (1858, p. 544).

[a] *Zeacrinites* from *Zea*—maize—one of my negro servants, being present when I found this specimen—"Ah! Masse" (he said) "a petrified corn cob"!—in fact it resembles as much a corn cob, as an *Apiocrinus* resembles a pear or a *Rhodocrinus* a rose.—So I am indebted for the name of this fossil to a descendant of an African race. I gave it only a scientific appearance, to which I have joined the name of another plant which adorns our western forests by the beauty of its flowers and delicacy of its perfume namely the magnolia, by which I was surrounded when I found it.

ZEACRINUS MAGNOLIÆFORMIS (Owen and Norwood).

Plate 12, figs. 3, 4.

Cyathocrinus magnoliæformis Owen and Norwood, Res. Protozoic Carb Rocks Kentucky, 1846.

Zeacrinites magnoliæformis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Zeacrinus magnoliæformis Hall, Rept. Geol. Surv. Iowa, I, Pt. 2, 1858, pp. 544, 684.—Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 128 (catalogue name).—Miller, North Amer. Geol. and Pal., p. 288 (catalogue name).—Keyes, Missouri Geol. Surv., IV, 1894, p. 214.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 652 (catalogue name).

Poteriocrinus (*Zeacrinus*) *magnoliæformis* Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 398 (catalogue name).

The original description by Troost is as follows:

It is elongated, cylindrical. Pelvis [infrabasal plates]—small pentagonal? Divided? [composed of five minute infrabasals].

This supposed pelvis lies in a deep cavity and is supported by a cylindrical column having a circular [pentalobate] alimentary canal [lumen]. The cavity being mostly fitted by the column—the form and even the existence of the pelvis [infrabasals] is very uncertain.

Costals, [radials] five, subtriangular, tumid—superior margin concave, and the lower convex, and being bent inwardly they form the base of the body and the sides of the cavity in the bottom of which, the pelvis? is situated.

Scapulars [primaxils] five—compressed pentagonal; four of them being placed immediately upon the concave surface of the costals [radials] and one upon an interscapular [first primibrach], their superior margin being cuneiform.

The scapulars [radials] support five arms, upon which follow immediately ten hands, which, after 2 or 3 [3 or 4] joints, have a cuneiform joint, dividing them into two fingers [branches] one of which continues single while the others about 5 joints distant, bifurcates again, and continues then without any further division.

I found some mutilated specimens in the Devonian [?] strata in Tennessee. The specimen represented [fig. 3, pl. 12] is from the vicinity of Huntsville, Alabama. The limestone in which it is imbedded, resembles mineralogically that of the vicinity of Nashville which is Silurian; but in Alabama it lies immediately below the Carboniferous strata of Mount Sano, which is characterized by *Pentremites*.

Observations.—In the Report of the Geological Survey of Iowa (Vol. I, Pt. 2) Hall published Troost's description of this species as a footnote in connection with his description of the genus, and later in the same report (p. 684) he published his own detailed description of the species. A diagram of the plates of Troost's specimen accompanies this description, but no figure of the type was given.

Formation and locality.—Kaskaskia limestone. Huntsville, Alabama; Grayson County, Kentucky; Chester, Illinois. Hall reports the species from Tennessee, but as he describes Troost's specimen only and gives Tennessee as its locality, the reference is doubtless an error.

Cat. No. 39936, U.S.N.M.

Genus COELIOCRINUS White.

COELIOCRINUS CARINIFEROUS (Worthen).

Cyathocrinites inflatus TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Zeacrinus cariniferous WORTHEN, Geol. Surv. Illinois, V, 1873, p. 535, pl. XX, fig. 4.

Cyathocrinus inflatus WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, I, 1879, p. 148 (catalogue name).

Coeliocrinus cariniferous WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, I, 1879, p. 133 (catalogue name). MILLER, North Amer. Geol. and Pal., 1889, p. 233 (catalogue name).—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898 p. 185 (catalogue name).

The description by Troost is as follows:

This crinoid deviates somewhat from the genus *Cyathocrinites* having instead of one interscapular [interbrachial], four small plates which occupy a space partly between the costals [radials] and the scapulars [primaxils], and the scapulars [primaxils] rest immediately upon the costals and not between them. The pelvis [base] is divided into five plates, which support five subpentagonal costals [radials] and these support five pentagonal scapulars [primaxils], upon which follow five arms with cuneiform terminations supporting two hands, being subdivided into two feathered fingers.

The capital integument is remarkable in this species. It does not, as in most of the crinoidea, terminate in a proboscis like aperture, or in a simple dome; but it rises above the cup, contracting gradually till it has about half the diameter of the cup when it increases again gradually in size, surpassing the diameter of the cup and terminates globular. The whole of the coronal integument resembling an elongated inflated bladder, much surpassing in length the whole cup—The cup of the specimen now before me, from its base to the superior part of the costals [radials] having about 6 mil. m. in height, while from the superior part of the costals [radials] to the termination of the integument its height is 18 mil. m. and its greatest diameter 9 mil. m.

Occurs very rarely in the oolitic limestone of the Cumberland Mountains, in Tennessee, and more abundantly in the vicinity of Huntsville, Alabama.

Observations.—The Troost collection contains four well-preserved specimens of this little species. Three of them show the balloon-shaped ventral sac distinctly, and one has the anal area especially well preserved.

Formation and locality.—St. Louis limestone. Near Huntsville, Alabama; Cumberland Mountains, Tennessee.

Cat. No. 39943, U.S.N.M.

Genus HYDREIONOCRINUS de Koninck.

HYDREIONOCRINUS DEPRESSUS (Hall).

Plate 11, figs. 6, 7, 8.

Cyathocrinites depressus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Zeacrinus depressus Hall, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 545, text figs. 66, 67.

Poteriocrinus (Zeacrinus) depressus Shumard, Trans. Acad. Sci., St. Louis, II, No. 3, 1866, p. 362 (catalogue name).

Hydreionocrinus depressus Wachsmuth and Springer (not Wetherby), Rev. Palæocrinoidea, I, 1879, p. 131 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 256 (catalogue name).—Weller (in part), Bull. No. 153, U. S. Geol. Surv., 1898, p. 310 (catalogue name).

Cyathocrinus depressus Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 148 (catalogue name).

The original description by Troost is as follows:

It differs from the *C. crateriformis* [*Eupachycrinus boydi*] by being less elevated—but it differs more particularly in the form of the costals [basals] and scapulars [radials]—the first shooting up lanceolate along the sides of the cup, while the latter (costals) [radials] being irregularly pentagonal with curvilinear edges fill up the interstices between the costals [basals]. The interscapulars [anal and right tube plate] are regular hexagons.

It occurs near White's Creek Springs, Davidson County, Tennessee, and in the vicinity of Huntsville, Alabama, both Carboniferous.

Observations.—In connection with his description of the genus *Zeacrinus*, Hall has published a brief description of this species, with diagrams of the plates, both exterior and interior views.

The excellent state of preservation of the dorsal cup of the type-specimen illustrates well the character of the thick plates of which it is formed. The infrabasals have the form of pentagonal prisms, of which the large bases form the inner floor of the calyx, while their truncated apices are the small infrabasals concealed beneath the column on the outside. The basals, which are large and petalloid on the outside, have only their tips showing in the angles between the infrabasals on the inside of the calyx. The long radianal extends downward between the posterior basal and the adjacent radial until its tip truncates that of an infrabasal plate. The special anal and right tube plate are preserved, as shown in the figures.

The arms, column, and tegmen are unknown, but the species may be referred to *Hydreionocrinus* on account of the similarity of the calyx to those of undoubted species of the genus.

Formation and locality.—Chester limestone. Near Huntsville, Alabama. Troost reports the species also from White's Creek Springs, Tennessee, but the four specimens in his collection are evidently all from one locality, and as their method of preserva-

tion resembles that of material from Huntsville, the latter reference may be an error.

Cat. No. 39969, U.S.N.M.

HYDREIONOCRINUS SPINOSUS, new name.

Hydreionocrinus depressus WETHERBY, Journ. Cincinnati Soc. Nat. Hist., III, 1881, p. 325, pl. IX, figs. 1–4, 6.—WELLER (in part), Bull. No. 153, U. S. Geol. Surv., 1898, p. 310 (catalogue name).

The specimens representing this species were carefully described by Wetherby (1881, p. 325) and referred to *Zeacrinus depressus* (Troost) Hall on the authority of Mr. Wachsmuth, although the author himself differed from Wachsmuth on the subject of the specific identification. He says, "Though Mr. Wachsmuth, to whom I have sent specimens of these crinoids, refers them to the species described by Meek and Worthen under the name of *Zeacrinus armiger*, Proc. Acad. Nat. Sci. Phila., and *Z. depressus* Troost, as defined by Hall,[a] I have every reason to believe that this reference is incorrect and that the fossils here figured are undescribed species. I do not, however, forget Mr. Wachsmuth's claim to be regarded as the highest American authority on these fossils, and refrain from adding any new names to the forms herein described at present, the more especially as I have had no authentic examples of the two species above mentioned with which to compare the specimens now under consideration and must therefore rely upon my own interpretation of the descriptions and figures in illustration of the species mentioned."

With the types of *Hydreionocrinus depressus* before me for comparison with Professor Wetherby's careful description and figures, it is evident that he was correct in believing that his specimens constituted a species distinct from that of Troost. The basals of Wetherby's type are relatively much shorter than those of *H. depressus*, having a length about equal to the width, and the long radianal plate of the latter is represented in the former by a short hexagonal plate, no part of which occupies a position between a basal and radial.

The first of the species mentioned above, *H. armiger*, has already been separated by Wachsmuth and Springer (1886, p. 245) as *H. wetherbyi*, and for the second the name *H. spinosus* is now proposed.

Formation and locality.—Chester group. Pulaski County, Kentucky.

[a] Geol. Rep. Iowa, I, Pt. 2, p. 546.

Family CROMYOCRINIDÆ Bather.

Genus EUPACHYCRINUS Meek and Worthen.

EUPACHYCRINUS MANIFORMIS (Yandell and Shumard).

Plate 11, fig. 4.

Cyathocrinus maniformis YANDELL and SHUMARD, Contr. Geol. Kentucky, 1847, p. 25, pl. I, fig. 2.

Cyathocrinites gracilis TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Zeacrinus maniformis HALL, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 682, pl. XXV, fig. 8.—SHUMARD, Trans. Acad. Sci. St. Louis, II, 1866, p. 399 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 288 (catalogue name).

Scaphiocrinus gracilis SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 362 (catalogue name).

Poteriocrinus (*Scytalocrinus*) *maniformis* WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, I, 1879, p. 117 (catalogue name).

Eupachycrinus maniformis WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, III, 1886, p. 249 (catalogue name).—KEYES, Missouri Geol. Surv., IV, Pt. 1, 1894, p. 217.—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 265 (catalogue name).

The description by Troost is as follows:

The pelvis is not visible. The costals [basals] are lanceolate, supporting in the re-entering angles five pentagonal scapulars [radials], upon which rest a cuneiform arm each supporting two hands.

Occurs near Sparta, White County, Tennessee, accompanied with *Pentremites* in oolitic limestone—I found it also near Huntsville, Alabama.—Both Carboniferous.

Observations.—The original description of this species is meager, but being accompanied by a good figure, it is possible to identify other specimens with the type. Hall published in 1858 (p. 682) an accurate and detailed description of the species. His figure represents a specimen with only one arm in the left postero-lateral ray, but, as he suggests, this is probably an abnormal individual. The specimen in the Troost collection has the normal two arms in this ray.

Formation and locality.—Kaskaskia limestone. Near Sparta, White County, Tennessee; Huntsville, Alabama; Chester, Illinois; Grayson County, Kentucky.

Cat. No. 39946, U.S.N.M.

EUPACHYCRINUS BOYDII Meek and Worthen.

Plate 7, figs. 1, 2, 3, 4, 5.

Cyathocrinites crateriformis TROOST, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Eupachycrinus boydii MEEK and WORTHEN, Proc. Acad. Nat. Sci. Phila., 1870, p. 30; Geol. Surv. Illinois, V, 1873, p. 554, pl. XXI, fig. 6.—WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, I, 1879, p. 138 (catalogue name); III, 1886, p. 249.—MILLER, North Amer. Geol. and Pal., 1889, p. 245 (catalogue name).—WELLER, Bull. No. 153, U. S. Geol. Surv., 1898, p. 264 (catalogue name).

Cyathocrinus crateriformis WACHSMUTH and SPRINGER, Rev. Palæocrinoidea, I, 1879, p. 148 (catalogue name).—MILLER, North Amer. Geol. and Pal., 1889, p. 235 (catalogue name).

The description by Troost is as follows:

Our crinoid resembles in external form some species of the genus *Poteriocrinites* particularly the *P. granulosus* of Phillips; but if we observe the arrangement of the plates, it can not be classed in this genus. According to Phillips *Poteriocrinites* is composed of a pelvis [infrabasals] (not known to Miller) and five costals [basals] (pelvis of Miller) consequently Miller's becomes a second series of costals [radials]. The *crateriformis* is composed of a pentagonal pelvis divisible into four [five] parts [infrabasals], five costals [basals] five scapulars [radials] and three interscapulars [anal plates]. We see that it does not belong to the category of the *Poteriocrinites*, nor does it exactly agree with the characters of the *Cyathocrinites*, the *crateriformis* having two hexagonal and one irregular interscapulars [anal plates]. We class it provisionally with the *Cyathocrinites*, till more complete specimens authorize us to form for it a new genus.

The *Cyathocrinites crateriformis* has a cylindrical column perforated with a circular alimentary canal [lumen]. Pelvis [base]—pentagonal, very small, more or less concave, forming the bottom of a deep cavity formed by the level part of the large tumid pentagonal costals [basals]. Five very tumid pentagonal costals [basals], the lower part of which form the whole of the sides of the pelvic cavity—then turning outwards they form the base of the cup, and turning upwards they form the side of the cup, where they assume a tumid almost globular form. Then follow five broad pentagonal scapulars [radials] the superior surface of which is provided with a groove for the reception of arms. Three irregular pentagonal intercostals [anals] complete the rim of the cup. The plates are all tumid. The whole of the complicated figure will be better understood by consulting the plates.

It was discovered in Decatur County, Tennessee.

Observations.—Troost's specimen of this species preserves only the dorsal cup to the top of the radials. His figure represents the sides of the calyx as much too divergent. They are vertical or even inclined slightly inward toward the top.

Formation and locality.—Chester group, Chester, Illinois; Tennessee? The locality given for Doctor Troost's specimen is Decatur County, Tennessee, but his collections from Decatur County are from the Brownsport limestone and the genus *Eupachycrinus* is not known to occur lower than the Mississippic horizon, hence there is probably an error in the locality label.

Cat. No. 39971, U.S.N.M.

Genus AGASSIZOCRINUS Troost.

Agassizocrinites Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850.—Owen and Shumard, Journ. Acad. Nat. Sci. Phila. (n. ser.), II, 1851, p. 93; Geol. Rep. Iowa, Wisconsin, and Minnesota, 1852, p. 597.—Shumard, Marcy's Rept. Red Riv. Exped. Louisiana, 1853, p. 173.—Hall, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 684.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 352.—Worthen, Geol. Rep. Illinois, V, 1873, p. 556.—Meek, Amer. Journ. Sci., 3d ser., VII, 1874, p. 484.—Zittel, Handb. d. Pal., I, 1879, p. 361.—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1886, p. 262.—Miller, North Amer. Geol. and Pal., 1889, p. 221.—Zittel, Text-Book Pal. (Eastman trans.), 1896, p. 162.—Bather, A Treatise on Zool., III, the Echinoderma, 1900, p. 181.

Astylocrinus Roemer, Leth. Geogn. (Ausg. 3), 1854, p. 229.—Dujardin and Hupé, Hist. nat. Zooph. Ech., 1862, p. 159.

The original description by Troost is as follows:

GENERIC CHARACTERS.

Pelvis—composed of five plates [infrabasals] terminating at the base in a solid point, without cicatrice for a column.

Costals [basals] five, subhexagonal.

Scapulars [radials] five, pentagonal.

Arms [primaxils] five, pentagonal.

Observations.—In Doctor Troost's formula the term arms is used for arm plates or primaxils. The arms are ten in number, large, uniserial and bear long pinnules.

Genotype.—Agassizocrinus dactyliformis Troost.

AGASSIZOCRINUS DACTYLIFORMIS (Troost) Shumard.

Plate 12, fig. 1.

Agassizocrinites dactyliformis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 62 (*nomen nudum*); MSS., 1850.

Agassizocrinus dactyliformis Shumard, Marcy's Rep. Red Riv. Louisiana, 1853, p. 173, pl. 1, fig. 7.—Hall, Rep. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 685.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 352 (catalogue name).—Meek and Worthen, Geol. Surv. Illinois, V, 1873, pl. xxi, figs. 7*a*, *b*.—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1886, p. 365 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 221 (catalogue name).—Keyes, Missouri Geol. Surv., IV., Pt. 1, 1894, p. 221.—Weller, Bull. No. 153, U. S. Geol. Surv., 1898, p. 74 (catalogue name).

The original description by Troost is as follows:

This crinoid, as is seen in the figure, has an obtuse conical form and is composed of:

Pelvis [base],—five plates ? irregular quadrilateral, two sides elongated and curvilinear, joining with the other plates, at the base in a solid point, two cycles forming the superior part, joined with the other plates, form the circular superior border.

Costals [basals]—five, subhexagonal,—they are placed in the reentering angles of the circular border of the pelvis.

Scapulars [radials], five pentagonal placed in the reentering angles of the series of the costals [basals].

Interscapulars [anal plates]—five, small, irregular plates.

Arms [primaxils], five, pentagonal supporting two hands [arms].

It is uncertain how the pelvis [base] is divided,—some traces of sutures are slightly visible but they are so closely anchylosed that no reliance can be put on them, and

judging from fragments of this pelvis in my collection no suture is visible, and only a very small cavity in its interior, and no traces of any canal towards the base being perceptible—in fact almost the whole pelvis is solid carbonate of lime.

All the plates are very thick. The articulating surfaces broad and transversely irregularly striated, and possess a small abdominal cavity.

It occurs near Huntsville, Alabama, in Carboniferous strata, and I found numerous fragments of it in the Silurian in Decatur County in Tennessee, so that it seems to belong to two geological ages.

Observations.—The infrabasals of Doctor Troost's type are not preserved, but his collection contains the infrabasals of a slightly larger individual used for the description. The transverse, irregular striæ, mentioned by Doctor Troost, on the upper surface of these plates are, no doubt, the ramifying furrows described by Wachsmuth and Springer [1886, p. 263].

Formation and locality.—Kaskaskia limestone. Huntsville, Alabama; Chester, Illinois; Washington County, Arkansas; Crittenden County, Kentucky.

The fragments reported by Doctor Troost as from Decatur County, Tennessee, are probably incorrectly identified, as his collections at that locality are from the Brownsport limestone and it is unlikely that the species persists from that horizon to the Kaskaskia.

Cat. No. 39918 U.S.N.M.

AGASSIZOCRINUS, species undetermined.

Plate 7, figs. 6, 7.

Agassizocrinites TROOST, MSS., 1850.

The description by Troost is as follows:

I possess numerous basal or pelvic parts of the *Agassizocrinites* which I think belong to other species. Some have the form as represented by fig. 2, plate 7, in which the joints are well preserved, in some of them the junctions are entirely obliterated. Others have the form of a segment of a sphere—in these no divisions are perceptible, and they probably belong to different species. They occur in different formations—I found some near White's Creek Springs—Carboniferous—others near Huntsville, Alabama, also Carboniferous, while the greatest number were found in Decatur County, Tennessee—Silurian.

Observations.—Of the fragments mentioned above only the one figured is to be regarded as possibly of an undescribed species. The specimen from which the figure is drawn is missing from the collection, but if the drawing is accurate it differs from *Agassizocrinus dactyliformis* in the shorter infrabasals and radials and consequently in the much shorter and broader calyx.

The locality of the figured specimen is not designated. Its horizon is probably Upper Mississippic or Carbonic as the genus is not known to have a wider range.

The fragments from Decatur County may belong to different species or even to different genera but in the absence of either descriptions or figures it is impossible to determine their character.

Family ENCRINIDÆ Bather.

Genus STEMMATOCRINUS Trautschold.

STEMMATOCRINUS TRAUTSCHOLDI Wachsmuth and Springer.

Plate 7, figs. 12, 13, 14.

Cyathocrinites robustus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*); MSS., 1850.

Cyathocrinus robustus Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 149 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 236 (catalogue name).

Stemmatocrinus trautscholdi Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1886, p. 256, pl. ix, figs. 7, 8.—Miller, North Amer. Geol. and Pal., 1889, p. 282 (catalogue name).—Weller, Bull., No. 153, U. S. Geol. Surv., 1898, p. 601 (catalogue name).

The description by Troost is as follows:

It is almost hemispherical, smooth and remarkably strong, the plates being very thick as is seen in the figure. The pelvis [base] is small—no divisions preceptible. The column is cylindrical, the costals [basals] short pentagonal and the scapulars [radials] broad and the whole of the superior margin excavated for the reception of the arms. No interscapulars [interbrachials] are visible.

Observations.—The description by Wachsmuth and Springer cited above gives all that is known of the species.

The four specimens in the Troost collection preserve only the dorsal cup to the top of the radials.

Formation and locality.—Keokuk horizon of the Tullahoma formation. Harpeth River and White's Creek Springs, Davidson County, Tennessee.

Cat. No. 39972, U.S.N.M.

Genus ERISOCRINUS Meek and Worthen.

ERISOCRINUS (?) BIPARTITUS (Troost).

Plate 6, figs. 8, 9.

Donaciocrinites bipartitus Troost, MSS., 1850.

The following description is by Troost:

The only difference between this and *D. simplex* seems to be the elevated ridge which runs longitudinally over the joints composing the hands. In this the cup is complete and shows the construction of the pelvis and superior plates.

Decatur County, Tennessee.

Observations.—Doctor Troost's specimen of this species has been misplaced and having only the figures and his somewhat meager description for the determination of the species it is placed with doubt in the genus *Erisocrinus*. The general form of the crinoid suggests that of *Erisocrinus whitei* Meek and Worthen, but the dorsal cup of the latter is much lower and the first arm plates are higher.

Order FLEXIBILIA Zittel.

Family ICHTHYOCRINIDÆ Bather.

Genus ICHTHYOCRINUS Conrad.

ICHTHYOCRINUS TIARÆFORMIS (Troost) Hall.

Plate 7, figs. 15, 16, 17.

Cyathocrinites tiaræformis Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Ichthyocrinus tiaræformis Hall, Rept. Geol. Surv. Iowa, I, Pt. 2, 1858, p. 558.—Shumard, Trans. Acad Sci. St. Louis, II, No. 2, 1866, p. 378 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 35.—Miller, North Amer. Geol. and Pal., 1889, p. 256 (catalogue name).—Weller, Bull. No. 153, U. S. Geol. Survey, 1898, p. 312 (catalogue name).

The description by Troost is as follows:

When I discovered this very perfect specimen I put it down as belonging to a new genus, as I found, or at least thought I found, nothing analogous to it in Miller or Goldfuss, I was therefore surprised when I got possession of Murchison's "Silurian System" to find a fine figure and description by Phillips of the *Cyathocrinites* [*Ichthyocrinus*] *pyriformis*, which, except in some specific differences, coincides with the fossil under consideration. I am glad nevertheless that Phillips himself says—"but in Miller's technical arrangement it ought probably to constitute a new genus."—It is therefore only necessary for me to mention in what respect it differs from the *C. pyriformis*.

Its difference in general dimensions is pretty considerable. The *C. tiaræformis* is 30 mill. m. long by a diameter of 35 mill. m.; the dimensions of the *C. pyriformis* taken from the figure in Murchison is 20 mill m. long and 15 mill. m. in diameter. The cicatrice for the column in the *tiaræformis* is about 8 mill. m. in diameter whereas that of the *pyriformis* seems hardly one-fourth of this dimension. In the *pyriformis* the pelvic [basal] plates do not project beyond the diameter of the column [?] and increase only slightly together with the costals.—In the *tiaræformis* on the contrary the pelvis [base] projects considerably beyond the column, the diameter of the column being 8 mill. m. while that of the pelvis [base], taken from one of the angles to the opposite edge is 11 mill. m. and increasing more rapidly in diameter at every series of successive plates till it terminates almost abruptly and forms an almost level summit which gives it somewhat the appearance of an oriental turban, (tiara from which its name).

But it differs still more from the *pyriformis* in the subdivision of the hands, we see on the figure of the *C. pyriformis* (Sil. Syst. pl. 17, fig. 6) that it terminates at the summit in 40 fingers, whereas, as appears from my figure, the *tiaræformis* terminates in 20 fingers.

I discovered it in Davidson County, Tennessee, near White's Creek Springs amongst the disintegrations of the Carboniferous and Devonian strata. It is changed into silex like most of the fossils of this locality. I found only one specimen, and it being without blemish it forms one of the ornaments of my collection. I never understood that even a fragment of it was found, so that it must be very rare.

Observations.—In Hall's description of this species [1858 p. 558] he speaks of the "absence of basal plates," but Troost's desciption emphasizes the projection of these plates beyond the column. Mr. Frank Springer who has the type in his possession assures me that

Troost is correct in his observation, the basal plates being distinctly visible beyond the column.

Formation and locality.—Keokuk horizon of the Tullahoma formation. White's Creek Springs, Tennessee.

Cat. No. 54236, U.S.N.M.

Genus CLEIOCRINUS Billings.

Campanulites Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 356 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 230 (catalogue name).—Bather, A Treatise on Zoology, III, The Echinoderma, 1900, p. 202 (catalogue name).

Cleiocrinus Billings, Rep. Progr. Geol. Surv. Canada, 1857, p. 276.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 359 (catalogue name).—Zittel, Handb. d. Pal., I, 1879, p. 357.—Wachsmuth and Springer, Rev. Palæocrinoidea, I, 1879, p. 35; III, 1886, p. 152.—Miller, North Amer. Geol. and Pal., 1889, p. 231.—Bather, A Treatise on Zoology, III, The Echinoderma, 1900, p. 191.—Springer, Mem. Mus. Comp. Zool., XXV, No. 2, 1905, p. 93.

Doctor Troost's description of *Campanulites* is as follows:

Body bell shaped or inverted conical, composed of polygonal plates.

Superstructure unknown.

Supported by a column composed of joints like the crinoids with a circular (?) alimentary canal [lumen].

Observations.—This meager description is supplemented by the detailed description of the species which was, no doubt, intended by the author to serve in partial definition of the genus. *Cleiocrinus* has since been fully defined in Mr. Springer's admirable monograph cited above.

CLEIOCRINUS TESSELLATUS (Troost).

Plate 7, fig. 11.

Campanulites tessellatus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 356 (catalogue name).—Miller, North Amer. Geol. and Pal., 1889, p. 230 (catalogue name).

The original description by Troost is as follows:

This fossil resembles more or less the figure of the *Echinosphærites tessellatus*, as represented by Deverneuil (see Russia vol. II, plate 27, fig. 7). I am not acquainted with the *E. tessellatus*, all my knowledge of it, is derived from the above mentioned work, from which it seems that the *Echinosphærites* are not supported by a column. Our fossil therefore must belong to a different genus, to which I have applied the name of *Campanulites*. Though our specimen is much mutilated, particularly near the base, it shows nevertheless that it was affixed to a stem with an alimentary canal [lumen], two entrochi being still attached to the body. I was not able to ascertain the construction of the base or pelvic plates it projecting only half above the limestone and this part principally is mutilated, while the other half of the fossil is entirely imbedded in it, and the fossil itself being carbonate of lime, I had no means to separate it from its matrix.

The plates of which the body is composed are polygons of various forms mostly compressed hexagonal. In proportion as the body increases in length, its diameter

increases also, notwithstanding the plates continue of the same size; but we find some of them changed, having then a cuneiform summit, which admits some additional plates in the following rows. These cuneiform or pentagonal plates seem to be irregularly dispersed over the body. The surface of the plates is slightly convex, and radiating striae run from the centre towards the sides.

This is the only character which distinguishes these plates from those of the *Melonites* which are granulated.

Nothing is known of its superior part as appears from the figure—I conjecture from some appearances that it terminated in an uniform margin.

I found it on the bank of Duck River near Columbia, Maury County, Tenn. The same Silurian as the vicinity of Nashville.

Observations.—As shown by the figure, only a portion of the calyx of this specimen is preserved, but the arrangement of the plates, their striated surfaces and crenulated sutures place it in the genus *Cleiocrinus*. The radiating ridges mentioned by Troost appear on plates preserving the outer surface but where this is removed the plates are crossed longitudinally by fine grooves which probably formed channels within the substance of the plates. These are continuous across adjacent plates.

The species is most nearly related to *C. magnificus* Billings, but it differs in the form of the body which was apparently more slender, and in the shape of the plates which are longer and narrower than in *C. magnificus*.

Formation and locality.—Lebanon limestone division of the Stones River formation. Duck River, near Columbia, Maury County, Tennessee.

Cat. No. 39910, U.S.N.M.

Order DICYCLICA CAMERATA Bather.

Family DIMEROCRINIDÆ.

Genus DIMEROCRINUS Phillips.

DIMEROCRINUS ROEMERI (Troost).

Plate 15, fig. 4.

Gilbertsocrinites roemeri TROOST, MSS., 1850.

The original description by Troost is as follows:

It is inverted conical. The column is cylindrical with a pentapetalous alimentary canal [lumen]. The plates are slightly tumous. The five arms are divided into ten hands before they reach the rim of the cup.

Decatur County, Tennessee.

Supplementary description.—Calyx obconical; height to the arm bases 12 mm.; greatest diameter 15 mm.

Infrabasals five, small, only their superior angles projecting beyond the column; basals large, thier lower portions slightly nodose; radiais the largest plates of the calyx; first primibrachs with a variable number

of sides—pentagonal or hexagonal; primaxil succeeded by two or three secundibrachs which are separated by an elongate intersecundibrach.

Interbrachial formula 1, 2, 2, 2. The first anal plate truncates the posterior basal and is succeeded by two rows of three plates each. The posterior basal with the succeeding anals form a straight longitudinal row of hexagonal plates decreasing in size upward.

The surface is without ornament except for the low nodes mentioned above and a faint ridge which begins at the upper margin of the radials and traverses the radial series of plates becoming stronger near the arm bases. The interbrachial and anal areas are not strongly depressed.

The tegmen, arms, and column are not preserved.

Upper stem joint circular, lumen pentalobate.

Observations.—This species resembles the specimens figured by Wachsmuth and Springer [1897, plate 18, figs. 6*a–d*], under the name of *Thysanocrinus inornatus*, but it differs from them in lacking the strongly elevated median row of anal plates and in the less pronounced depressions between the arms. The present specimens are also smaller than those figured by Wachsmuth and Springer.

Formation and locality.—Brownsport limestone. Decatur and Perry counties, Tennessee.

Cat. Nos. 39968, 39979, U.S.N.M.

Family LAMPTEROCRINIDÆ Bather.

Genus LAMPTEROCRINUS Roemer.

Balanocrinites Troost (not Agassiz 1845), Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*); MSS., 1850.

Lamptcrocrinus Roemer, Die. Sil. Fauna des westl. Tenn., 1860, p. 37.—Hall, Trans. Albany Inst., IV, 1863, p. 202.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 378 (catalogue name).—Hall, 20th Rep. New York State Cab. Nat. Hist., 1868, p. 328.—Zittel, Handb. d. Pal., I, 1879, p. 375.—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 199.—De Loriol, Pal. Française, XI (Crinoides), p. 59.—Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 101.—Miller, North Amer. Geol. and Pal. 1889, p. 257 (catalogue name).—Zittel, Text-Book Pal. (Eastman trans.), 1896, p. 145.—Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 207.—Bather, A Treatise on Zoology, III, The Echinoderma, 1900, p. 199.

The original description by Troost is as follows:

GENERIC CHARACTERS.

Pelvis [base] pentagonal, divisible into five parts.

Column pentagonal with circular alimentary canal [lumen] articulating surface striated near the margin.

Costals [basals] first series five, pentagonal, placed upon the five sides of the pelvis, forming a pentagon with five re-entering angles.

Second series [radials] five, heptagonal, placed in the re-entering angles of the pentagon formed by the first series of costals [basals].

Scapulars [second primibrachs], five, pentagonal, the superior angle cut out for the insertion of arms, which are placed upon the heptagonal [?] plates of the second series of costals [primibrachs].

Interscapulars [interbrachials] five, pentagonal placed in the angles formed by the heptagonal plates of the second costals [radials], and support three small tumous plates between the arms upon which rest the coronal integument [tegmen].

Arms, five—subdivision unknown.

Observations.—The name *Balanocrinus* was preoccupied, having been used by Louis Agassiz in 1845 for a genus of the family Pentacrinidæ. Full descriptions of this genus, references to which are to be found in the synonymy, have been given by Roemer, Wachsmuth and Springer, and others.

LAMPTEROCRINUS TENNESSEENSIS Roemer.

Plate 7, figs. 8, 9, 10.

Balanocrinites sculptus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 60 (*nomen nudum*), MSS., 1850.

Lampterocrinus tennesseensis Roemer, Die Sil. Fauna des westl. Tennessee, 1860, p. 37, pl. iv, figs. 1*a–d*.—Shumard, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 379 (catalogue name).—Wachsmuth and Springer, Rev. Palæocrinoidea, II, 1881, p. 201 (catalogue name).—Miller, North Amer. Geol. and Pal., p. 257 (catalogue name).—Wachsmuth and Springer, North Amer. Crinoidea Camarata, 1897, p. 208, pl. xiii, figs. 10 *a–d*.

The following description is by Troost:

It resembles the acorn of the oak particularly if we consider it without the column. It has apparently a cylindrical form but when we take a top or bottom view it is pentagonal. It is beautifully and regularly ornamented with elevated ridges, proceeding from the angles of the pentagonal column and ascending to the centres of the costals [basals]. From five to six of these ridges join together in the centre of the first series of costals [basals]; on the second series, (heptagonal plates) we have from six to seven, on the scapulars [first primibrachs] we have only three which join together immediately below the arm joints, while on the interscapulars [interbrachials] we have again from five to six ridges forming in this manner by their junction a number of acute and obtuse triangles and ornamenting the whole surface most elegantly, and which will be better conceived by examining the figures than can be conveyed by words. In these delineations I have endeavored to represent the different sides of the fossil which show any variation in the configuration produced by the irregularity in the number of these ridges on the various plates, which arrangement on the whole exhibits such remarkable regularity. In most of them these ridges are single as represented in the figures, in others, without exhibiting a specific difference, they are double and triple, and in this case the joints of the plates are obliterated.

They occur in Decatur County, Tennessee, where they are pretty abundant, nevertheless perfect specimens are rarely met with—they are mostly changed into silex.

Observations.—Doctor Troost failed to recognize the existence of more than one primibrach in the radial series, hence his figures are incorrect in the upper portion of the calyx.

The full description of the species by Roemer did not appear until ten years after Troost's description and figures were ready for publication, but as the former is the first to be published the species is lost to Troost.

Formation and locality.—Brownsport limestone, Eucalyptocrinus zone of the Beech River formation. Decatur and Wayne counties, Tennessee.

Cat. No. 39920, U.S.N.M.

Family RHODOCRINIDÆ Bather.

Genus DIABOLOCRINUS Wachsmuth and Springer.

DIABOLOCRINUS VESPERALIS (White).

Gilbertsocrinites americanus Troost, Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 61 (*nomen nudum*).

Rhodocrinus vesperalis White, Proc. U. S. Nat. Mus., II, 1879, p. 252, pl. 1, figs. 11, 12.—Wachsmuth and Springer, Rev. Paleocrinoidea II, 1881, p. 212 (catalogue name).—White, 12th Ann. Rep. U. S. Geol. Surv. Terr., Hayden, 1883, p. 129, pl. xxxv, figs. 4*a*, *b*.—Miller, North Amer. Geol. and Pal., 1889, p. 278.

Lyriocrinus sculptilis Miller (not Hall, 1851), Journ. Cincinnati Soc. Nat. Hist., V, No. 2, 1882, p. 83, pl. III, figs. 6, 6*a*–*b*.

Lyriocrinus sculptus Miller, Journ. Cincinnati Soc. Nat. Hist., V, No. 3, p. 117.

Archæocrinus sculptus Wachsmuth and Springer, Rev. Palæocrinoidea, III, 1885, p. 98.—Miller, North Amer. Geol. and Pal., 1889, p. 225 (catalogue name).

Diabolocrinus vesperalis Wachsmuth and Springer, North Amer. Crinoidea Camerata, 1897, p. 251, pl. xi, figs. 1*c*, *d*.

The following description is by Troost:

I believe this species is the first of the genus *Gilbertsocrinites* established by Phillips, that has been found in the United States. It resembles, in its general form, none of those that are figured by Phillips. (Phillips, Geol. of Yorkshire, pl. 4.)

It is compressed—globular. The pelvis [infrabasals] which is sunk in an excavation, is small, pentagonal and perforated by a circular, more or less lobated aperture, and divided into five parts. It supports five elongated hexagonal costals [basals] forming a decagon with five reentering angles, which supports five heptagonal 2nd costals [radials] and five pentagonal intercostals [interbrachials], placed in the reentering angles. The heptagonal plates bearing five pentagonal scapulars [primibrachs] from which proceed the arms divided into hands. The capital integument is more or less globular and terminates in the centre in a proboscis-like aperture, and is covered with numerous small polygonal plates.

It occurs in the vicinity of Knoxville, East Tennessee, which I consider as the inferior Silurian, and is associated with *Calymene fischerii*.

Observations.—Doctor Troost's specimens are typical and well preserved individuals of the species.

Formation and locality.—Trenton group. Near Knoxville, Tennessee.

Cat. No. 39970, U.S.N.M.

Genus SIDEROCRINUS Troost.

Siderocrinites Troost, MSS., 1850.

The specimen upon which this genus is founded shows only the inner surface of the basal portion of a large crinoid which had a deep basal excavation. It retains only the infrabasals, basals, and two radials. The basal excavation of the specimen makes its inner surface convex, and it was naturally mistaken by Troost for the outer surface of a convex form. Farther clearing away of the matrix reveals the presence of a long spine on the outer surface of the radials which determines the orientation of the specimen. Being founded upon a misconception of the nature of the specimen, Doctor Troost's description is misleading and has been omitted.

Supplementary description.—There are five large infrabasals, and five thick basals, truncated across their upper margins. These are the largest of the plates preserved. Radials quadrangular, their inner surface traversed by two sharp ridges with rounded hollows between them. These ridges start from near the proxinal margin of the plates and diverge slightly toward the outer margin, where they are about one third the width of the plates apart. The outer surface of the radial bears a long spine, about 2 mm. in diameter at its base. The one uncovered from the matrix was broken off at a length of about 3 mm. The upper margin of the radial is crenulate, but it is difficult to determine how much of this crenulation may have been produced by fracture or solution.

Observations.—The genus seems to be related to *Gilbertsocrinus*, but differs from it in the peculiar form of the basals and radials. It is recorded from a horizon much lower than that of any described species of *Gilbertsocrinus*. On the whole the fossil is a puzzling one and too poorly preserved for an altogether satisfactory determination of its affinities.

SIDEROCRINUS ORNATUS Troost.

Plate 12, fig. 7.

Siderocrinites ornatus TROOST, MSS., 1850.

The name *ornatus* refers to the two diverging ridges on the interior of the radials and the fluted character of their distal margins.

Formation and locality.—Brownsport limestone. Decatur County, Tennessee.

Cat. No. 39935, U.S.N.M.

Class STELLEROIDEA Gregory.

Genus PALAEASTER Hall.

PALAEASTER ANTIQUA (Troost).

Plate 8, fig. 1.

Asterias antiqua TROOST (not HISINGER 1837), Trans. Geol. Soc. Pennsylvania, I, 1835, p. 232, pl. x, fig. 9; Proc. Amer. Ass. Adv. Sci., II (read 1849), 1850, p. 59 (catalogue name).

Petraster antiqua SHUMARD, Trans. Acad. Sci. St. Louis, II, No. 2, 1866, p. 386 (catalogue name).

Palaeaster (Argaster) antiqua HALL, 20th Rep. New York State Cab. Nat. Hist., rev. ed., 1870, p. 329.

Palaeaster antiquus MILLER, North Amer. Geol. and Pal., 1889, p. 265 (catalogue name).

Argaster antiqua GREGORY, Geol. Mag., 4th dec., VI, 1899, p. 345 (gen. ref.).

The following description is by Troost:

I described the *Asterias antiqua* in a memoir read before the Geol. Soc. of Pennsylvania, which was published in the transactions of that society in April, 1834 (vol. 1, pag. 232). Since that time two naturalists have given the name of *Asterias antiqua* to different species of *Asterias*—Hisinger in his Lethaea Sveciaca Holmiae 1837 pag. 89 Tab. 26, fig. 6, and Professor Locke of Cincinnati. (I do not recollect where

the latter has published his description.) As the Tennessee fossil has priority, I will continue to consider it as *Asterias antiqua*.

The plate which accompanied the description in the transactions mentioned above, does not give the true figure of this *Asterias*, I subjoin here a better representation under figure 1.

I stated in the memoir (loco cit.) that other *Asterias* occurred in the strata of Tennessee. One of them after proper investigation I consider merely a parasite. Of this parasitic fossil two individuals are attached to the interior surface of an *Orthis formosa*, the one is 8 mil. ms. from the tip of one of the rays to that of the opposite ray, while the other is microscopic.

It occurs in Decatur County, Tennessee in Silurian Limestone. The second above mentioned although very mutilated, I will now describe under the name of *Comatula? prisca*—and the third under the name of *Astrias tennesseeæ*.

The *Asterias antiqua* is a rare fossil.—The specimen here figured is the only one that I have seen—very rarely fragments of it are found. They are generally so incorporated with the limestone, that it is impossible to develop any from its matrix. The one which is here figured was brought to light by erosion; it fortunately lying parallel to the eroded surface;—the fossil, being likewise carbonate of lime, is also more or less eroded at its surface. It was found in the Silurian limestone on Harpeth River, Davidson County, Tennessee. Associated with *Spirifer lynx* [*Platystrophia biforata lynx*], *Cyathophlla* [*Streptelasma*], *Orthis* [*Dalmanella testudinaria*], &c.

The only starfish in the Troost collection is in the possession of Prof. Charles Schuchert. He informs the writer that Hall's description of this specimen is erroneous and that it belongs to a new genus. A description of both genus and species will soon be published by Professor Schuchert.

In the absence of the specimen no changes or corrections could be made in Troost's description.

FOSSILS OF UNCERTAIN RELATIONSHIP.

Asterias tennesseeæ.—The specimen described under this name is a large silicious pseudomorph, the character of which is well shown by Troost's figure (plate 8, fig. 11). Its parts being arranged on a plan of five, the pseudomorph probably had some portion of an echinoderm as a basis for its growth, but the original structure is too completely obliterated to determine what this may have been.

The specimen was found in the Tullahoma formation of Cannon County, Tennessee.

Cat. No. 39913, U.S.N.M.

Comatula prisca.—The specimen to which Doctor Troost has given this name is missing from his collection. The figure shows an approximately circular body with eight irregular rays. It is probably the root of a crinoid.

Class ECHINOIDEA Agassiz.

Order MELONITOIDA Gregory.

Genus MELONITES Norwood and Owen.

MELONITES MULTIPORA Norwood and Owen.

Doctor Troost records the occurrence of *Melonites multipora* in Tennessee. He says of these specimens:

The plates of the *Melonites* which we find in Tennessee and which coincide with the figures of the *assulae Asteria quinquelobe* of Goldfuss (see loco. cit.) are short hexagonal prisms more or less laterally compressed, wedge shaped, superior or external surface, generally smooth.

The animals to which these plates belonged must have been very abundant at the period of the formation of our lower Carboniferous or Superior Devonian Strata which prevail in Stewart, Montgomery, Humphreys and Dickson Counties namely over the principal iron region of Tennessee—some parts of the strata are almost entirely made up of these plates—and large numbers of them may be collected from the disintegrations of these rocks—they are siliceous and generally associated with *Cidarites tennesseæ*, *Pentremites florialis*, Trilobites (Calymene?) joints and other parts of crinoids, (circular and elliptical) Fenestellae and fragments of shells—bivalves).

MELONITES GRANULATUS Troost.

Melonites granulatus Troost, MSS., 1850.

Compare *Melonites giganteus* Jackson, Bull. Geol. Soc. Amer., VII, 1896, p. 172, pl. IV, fig. 19; pl. V, figs. 21–24.

The description by Troost is as follows:

The fragment of this fossil which is in my possession is small and is composed of parallel ridges or undulations, three elevations and two depressions, and it is so indefinite that I cannot vouch that it really belongs to the *Melonites*. Nevertheless the form and the arrangement of the plates show a great analogy to this genus. If so it must form a distinct species of it.

It is composed, 1st., of a longitudinal elevation of about 3 cent. met. broad, of granulated, hexagonal plates of different sizes interlocking each other (the fragment contains six rows but it is only part of the elevation). 2nd. Then follows a depressed field running parallel to the elevation, of about 12 mil. met. transverse, on which follows, 3rd., an elevation which is about 10 mil. met. transverse, and this is succeeded, 4th, by a depression like the 2nd., and 5th., an elevation like the 3rd. My fragment goes no farther.

The first large longitudinal elevation, as stated above, is constructed of hexagonal plates. The second, the depressed field,—on this no joints of hexagonal plates are perceptible, but it exhibits several pairs of pores placed in a regular order.

The third elevation is again composed of hexagonal plates like the principal one [but less regular in shape and smaller], the fourth is again constructed like the above described bi-porous field, while the last elevation is constructed of hexagonal plates. The fragment in my cabinet which seems only a small part of a whole, is three inches transversely, and the surface of the plates from 5 to 7 mil. met. transversely, so it seems it was much larger than the *M. multipora* the whole of which measured transversely, according to Norwood and Owen, 4.2 inches.

It occurs in East Tennessee between Tazewell and Cumberland Gap, Claiborne County. It is carbonate of lime and imbedded in limestone which resembles the compact Silurian limestone of the vicinity of Nashville. In this respect it differs from the preceding species which is siliceous and occurs in a higher geological position. The geological disposition of the place where I found it is difficult to deter-

mine. The Carboniferous and older strata are, in Claiborne County, so near each other and so often in contact, that I am not able to state its true geological age.

Observations.—Doctor Troost's type of this species was at first referred to *Melonites giganteus* Jackson. The specimen has recently been sent to Doctor Jackson who considers it a distinct species. In accordance with the views of this high authority Troost's species is retained, but in the absence of the types of both species I am unable to say in what respect *M. granulatus* differs from *M. giganteus* Jackson. Troost's specimen has extremely thick plates and a strongly tuberculate surface. The plates of the ambulacral area are too much eroded to reveal their outlines, but pairs of pores show distinctly on many of them. The fragment apparently comes from near the ambitus of a large specimen.

Formation and locality.—Mississippic. Cumberland Gap, Tennessee.

Cat. No. 39909, U.S.N.M.

Cidarites tennesseeæ.—This name is given to a number of spines not represented in the collection. According to the figures, plate 8, figs. 2–5, they probably belong with the Cidaridæ, but our information is too meager to place them with the proper species.

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DESCRIPTION OF PLATES.

The figures on Plates 1 to 8 and figures 1 to 4 on Plate 13 are the original figures accompanying Doctor Troost's monograph. They were drawn by Major A. Heiman. All other figures are from original drawings or from photographs retouched by the author.

All figures are of natural size unless otherwise stated.

EXPLANATION OF PLATE 1.

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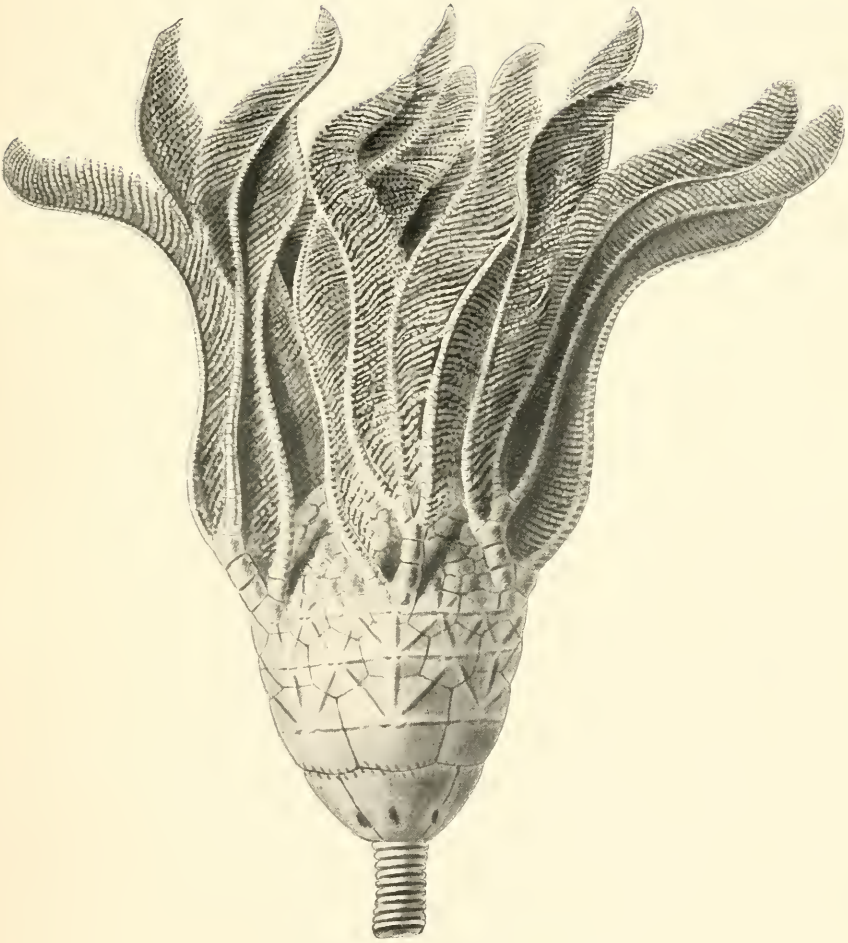
Actinocrinus magnificus Wachsmuth and Springer. A restoration by Maj. A. Heiman; about one-half natural size 80

This plate was intended by Troost to stand as the frontispiece of his monograph.



TROOST'S CRINOIDS OF TENNESSEE.

EXPLANATION OF PLATE 2.

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2. *Caryocrinus bulbulus* Miller and Gurley, side view of the specimen described by Troost as *Caryocrinites hexagonus* 11

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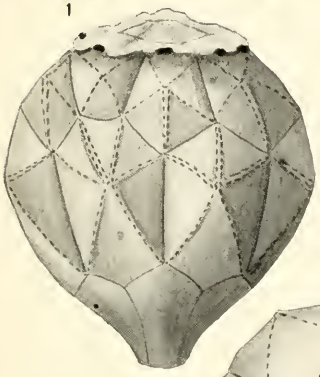
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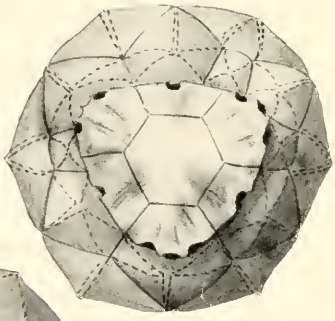
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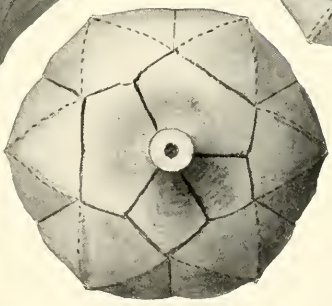
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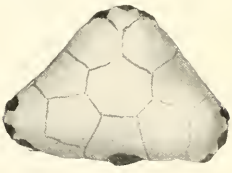
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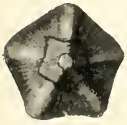
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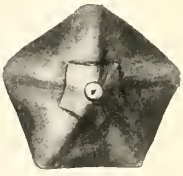
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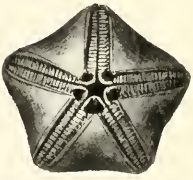
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TROOST'S CRINOIDS OF TENNESSEE.

EXPLANATION OF PLATE 3.

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Fig. 1. *Pentremites florealis* Say, side view. ×1½ 15

2, 3, 4. *Troostocrinus reinwardtii* (Troost), side, top, and basal views of Troost's type of *Pentremites reinwardtii*. ×1½ 17

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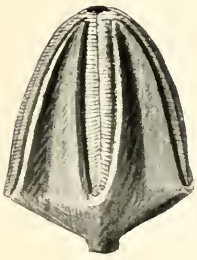
14, 15, 16. *Pentremites sulcatus* Roemer, side, top, and basal views of a large specimen. This is from Troost's type of *Pentremites cherokeus*. 16



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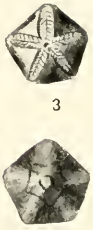

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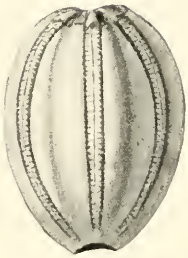

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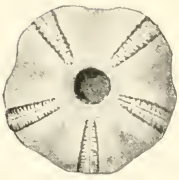

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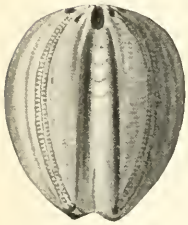

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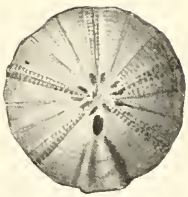

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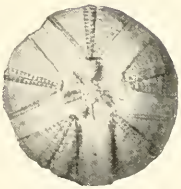

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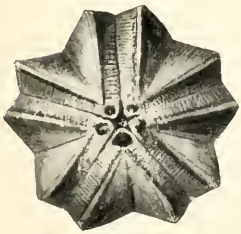

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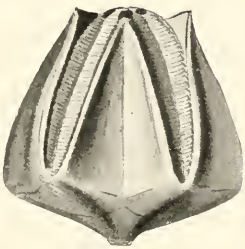

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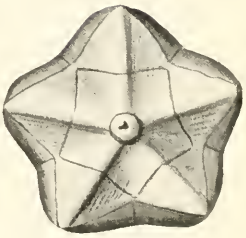

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TROOST'S CRINOIDS OF TENNESSEE.

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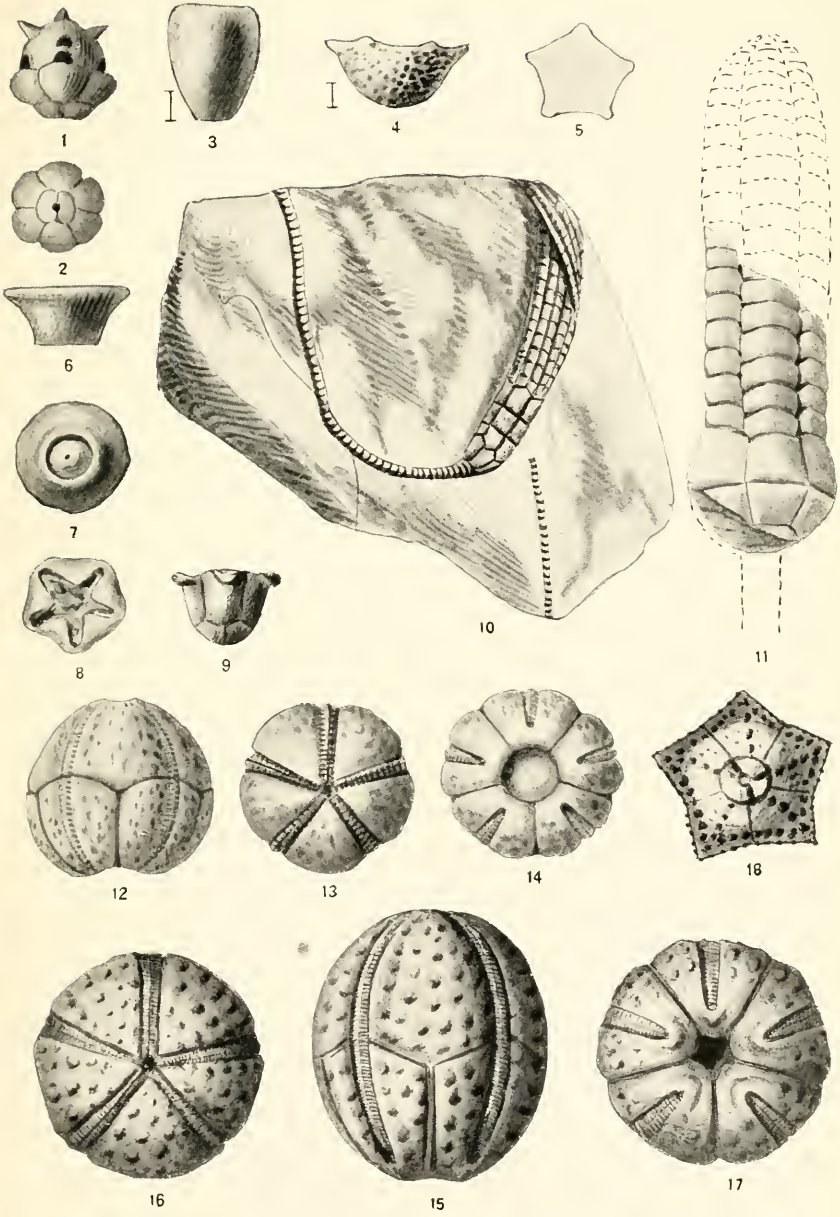

TROOST'S CRINOIDS OF TENNESSEE.

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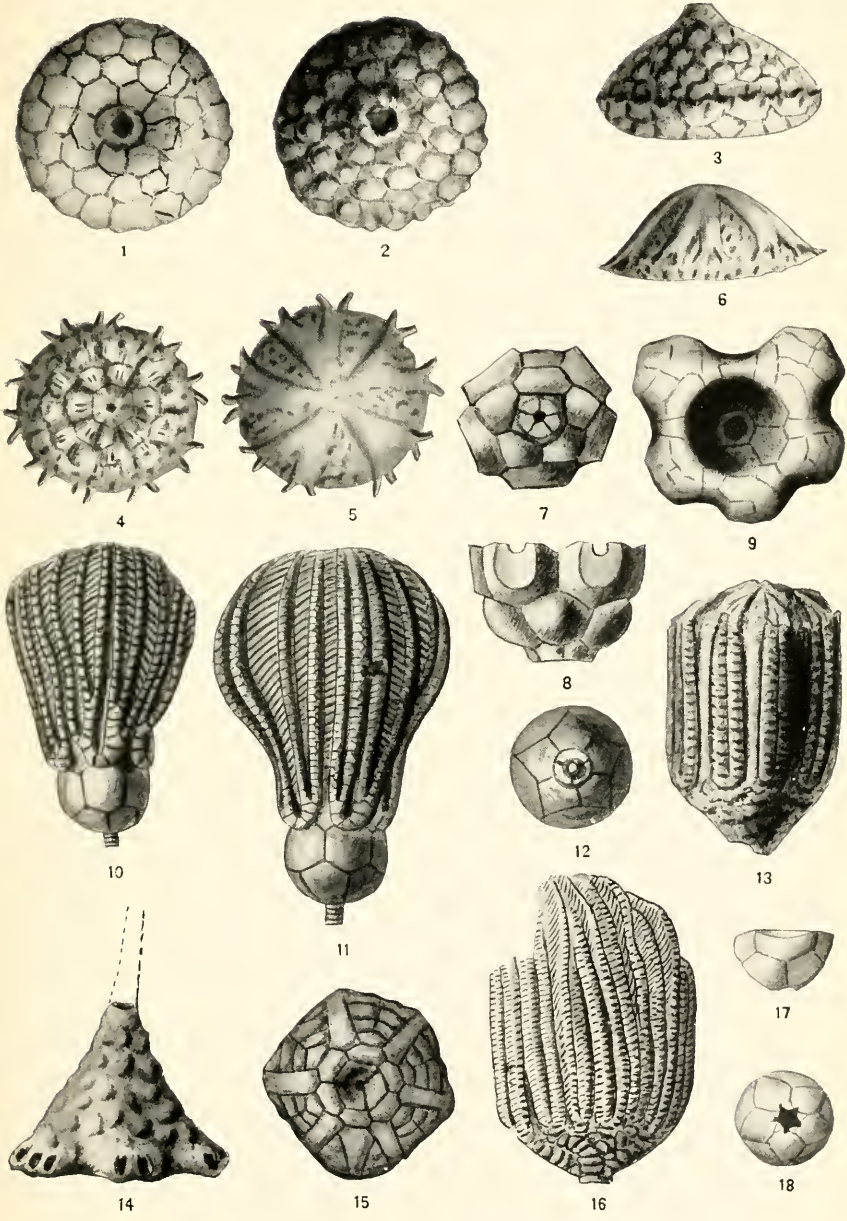

TROOST'S CRINOIDS OF TENNESSEE.

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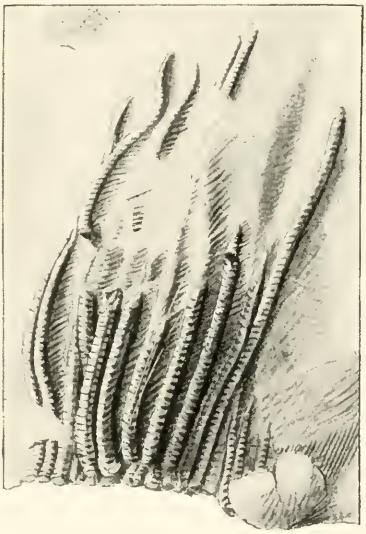

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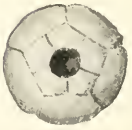

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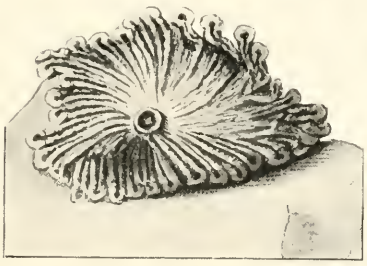

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TROOST'S CRINOIDS OF TENNESSEE.

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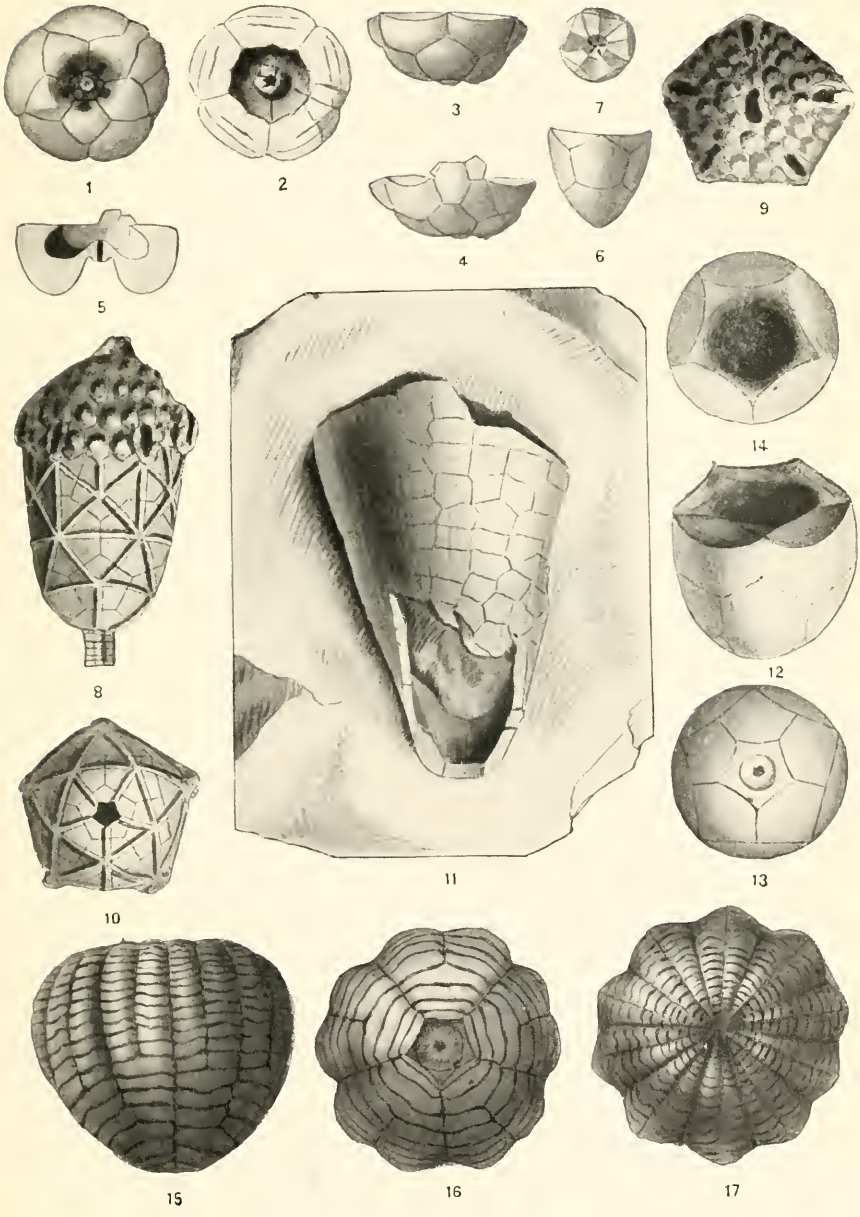

TROOST'S CRINOIDS OF TENNESSEE.

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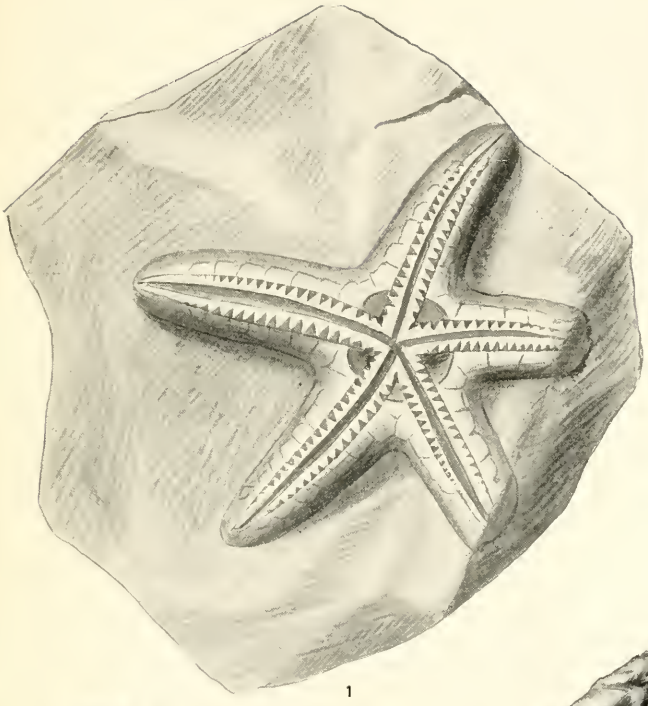

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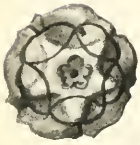

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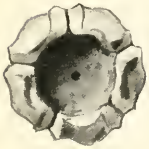

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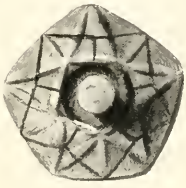

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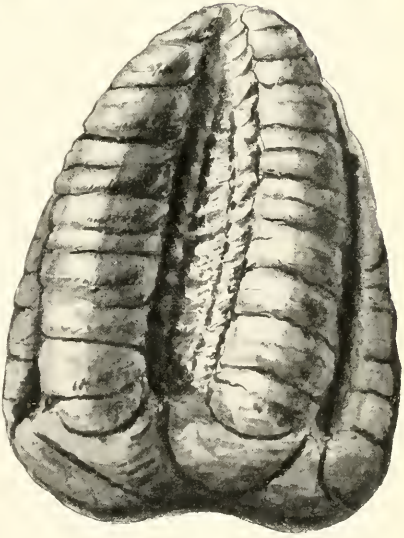

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TROOST'S CRINOIDS OF TENNESSEE.

EXPLANATION OF PLATE 9.

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Fig. 1. *Catillocrinus tennesseæ* (Troost) Shumard, top view of the dorsal cup, of the type-specimen, showing the thick wall and the arm bases. ×1½ 24

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13, 14. *Marsipocrinus striatus* (Wachsmuth and Springer), basal and side views of Troost's type of *Cupellæcrinites striatus* 33

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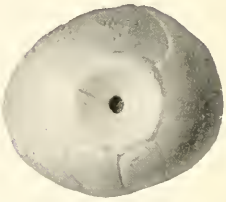

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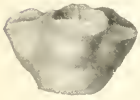

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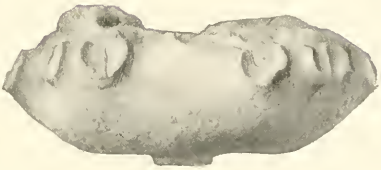

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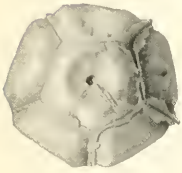

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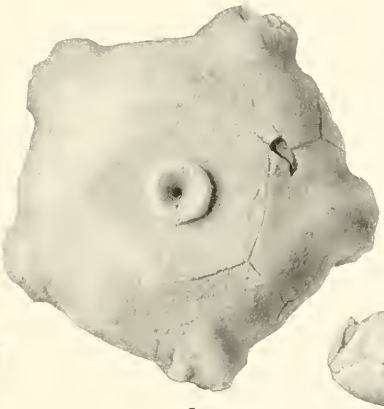

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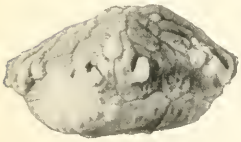

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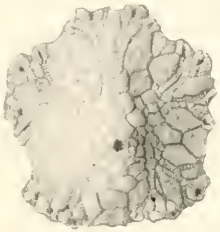

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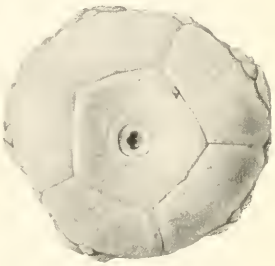

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TROOST'S CRINOIDS OF TENNESSEE.

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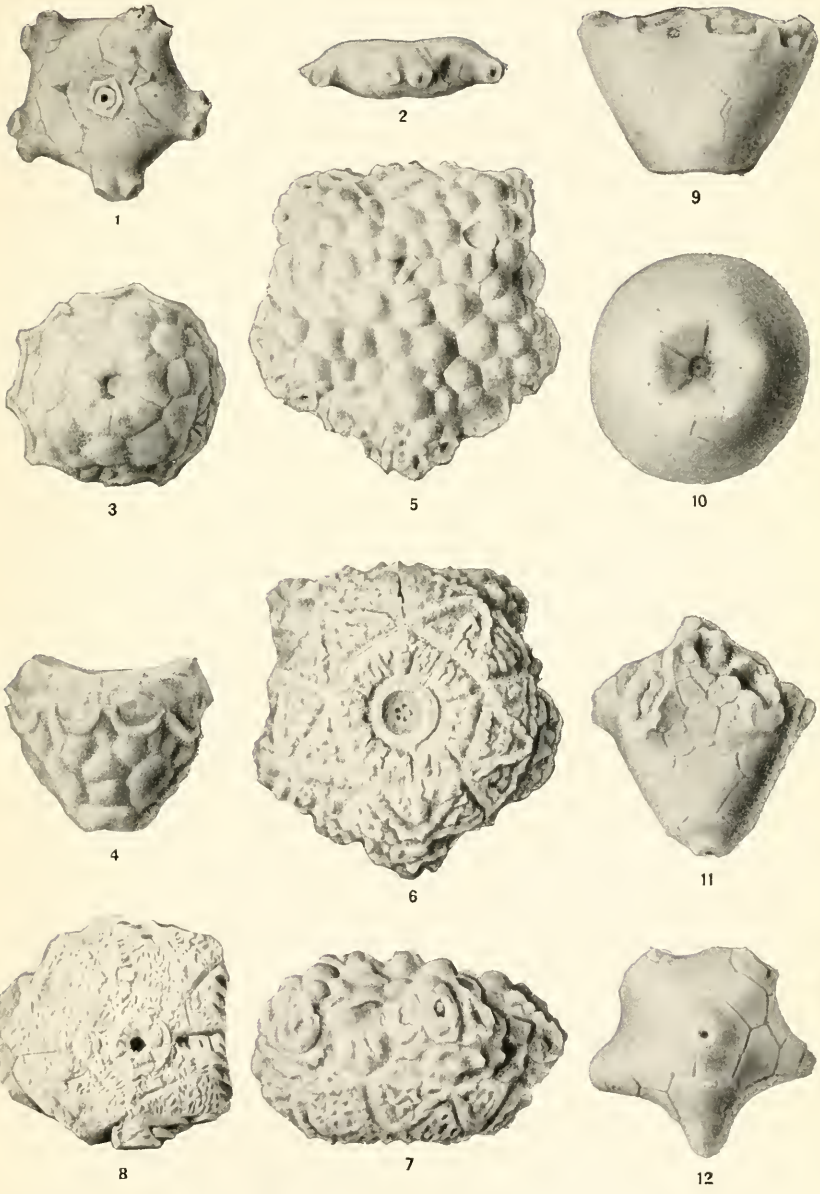

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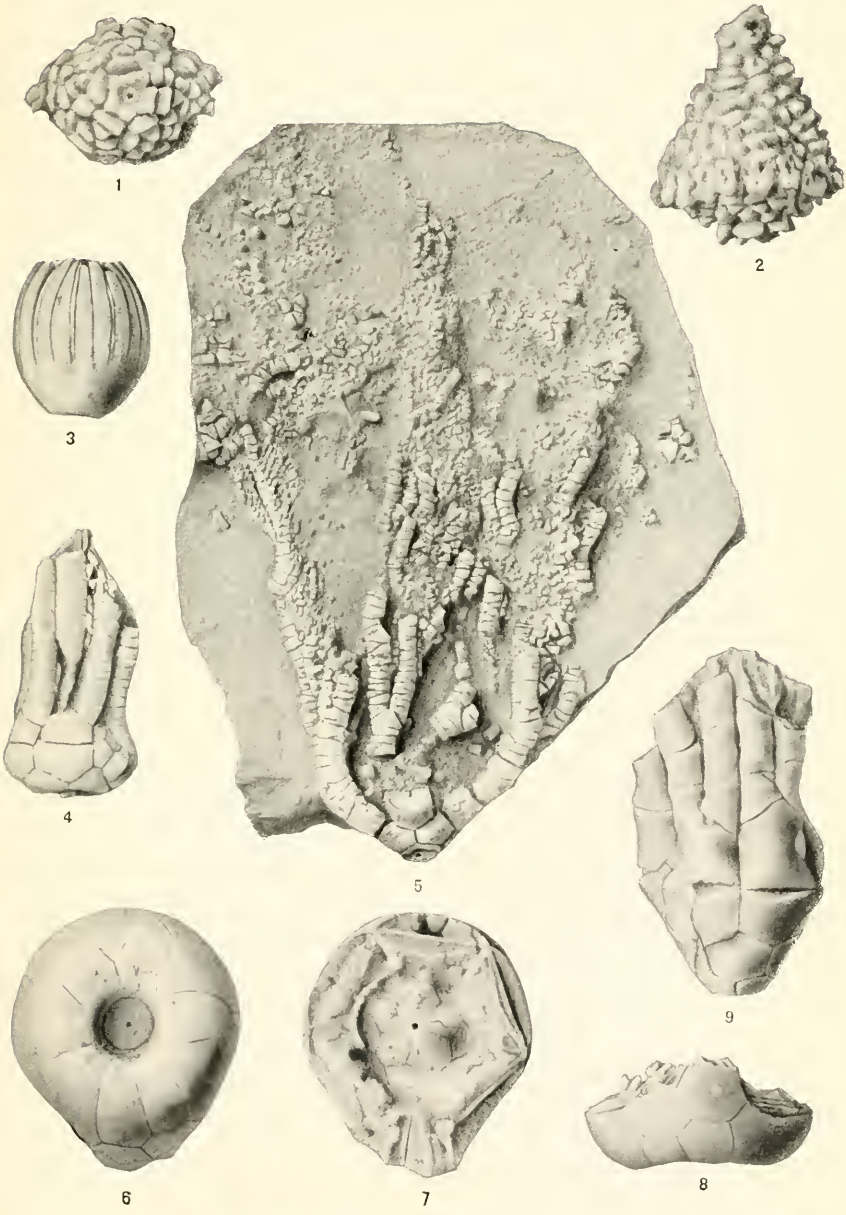

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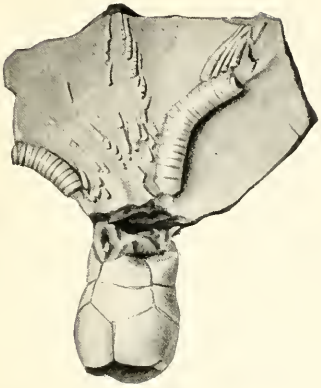

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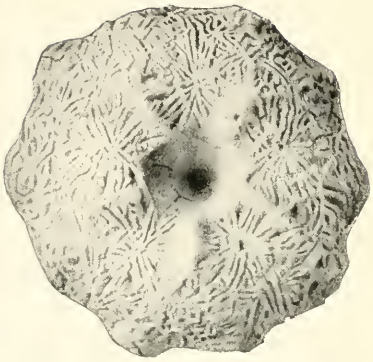

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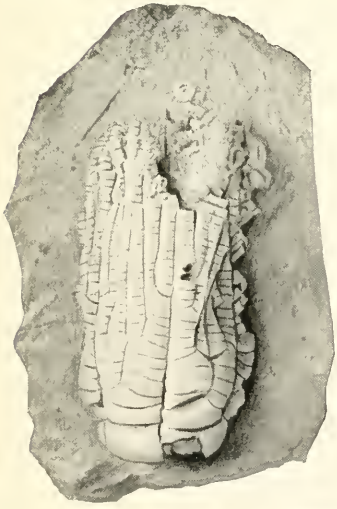

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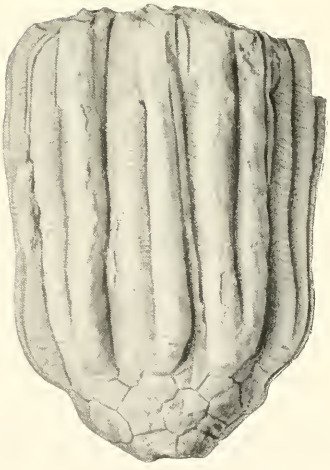

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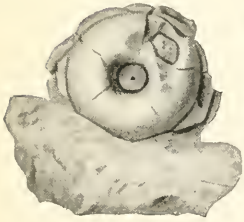

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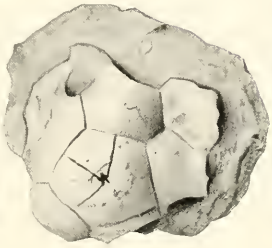

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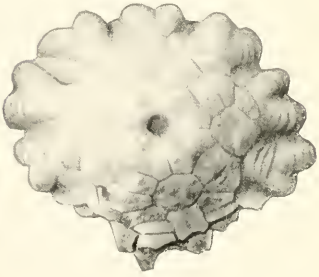

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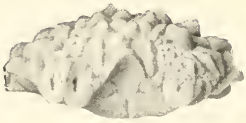

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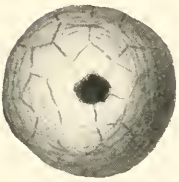

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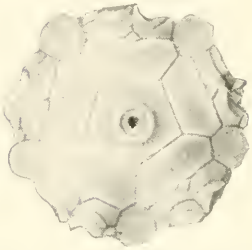

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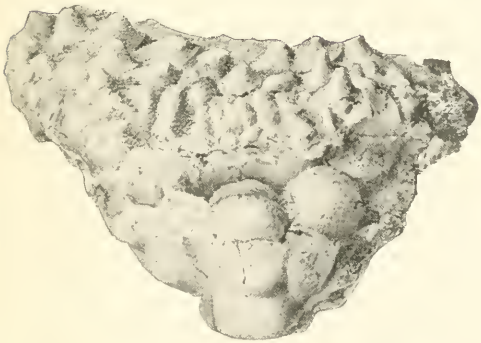

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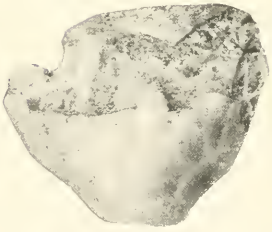

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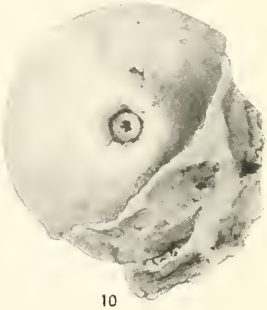

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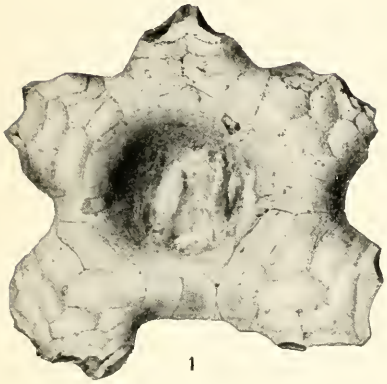

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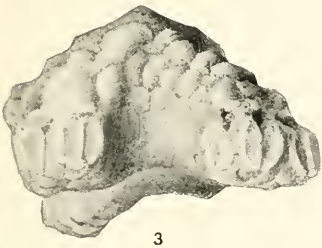

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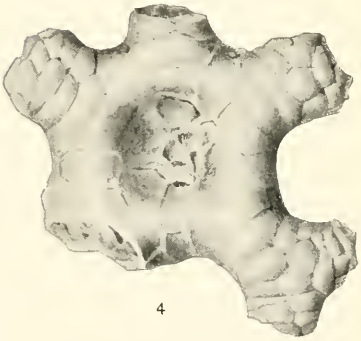

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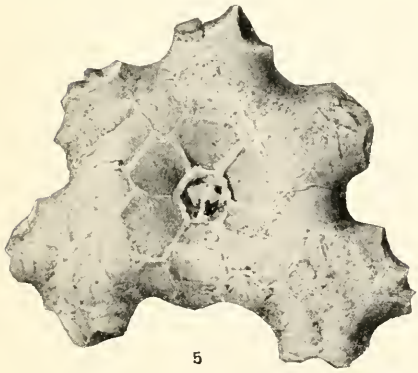

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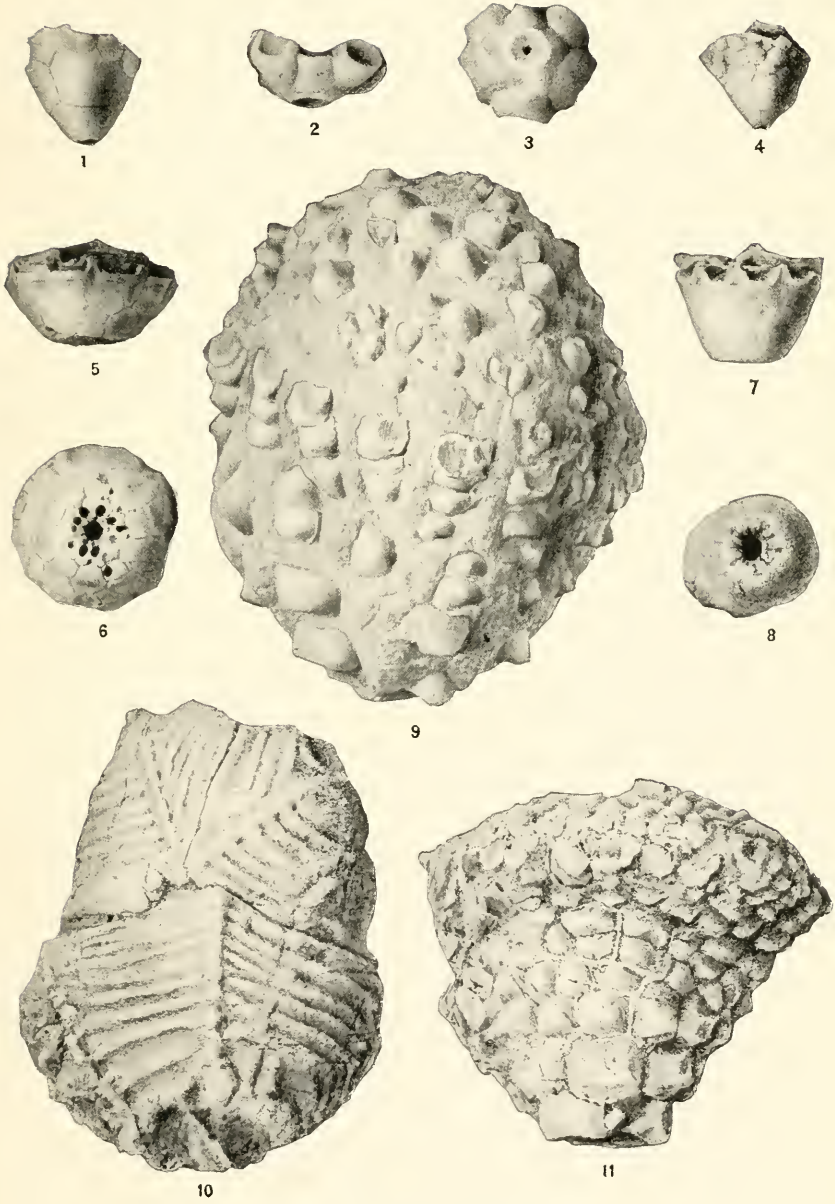

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